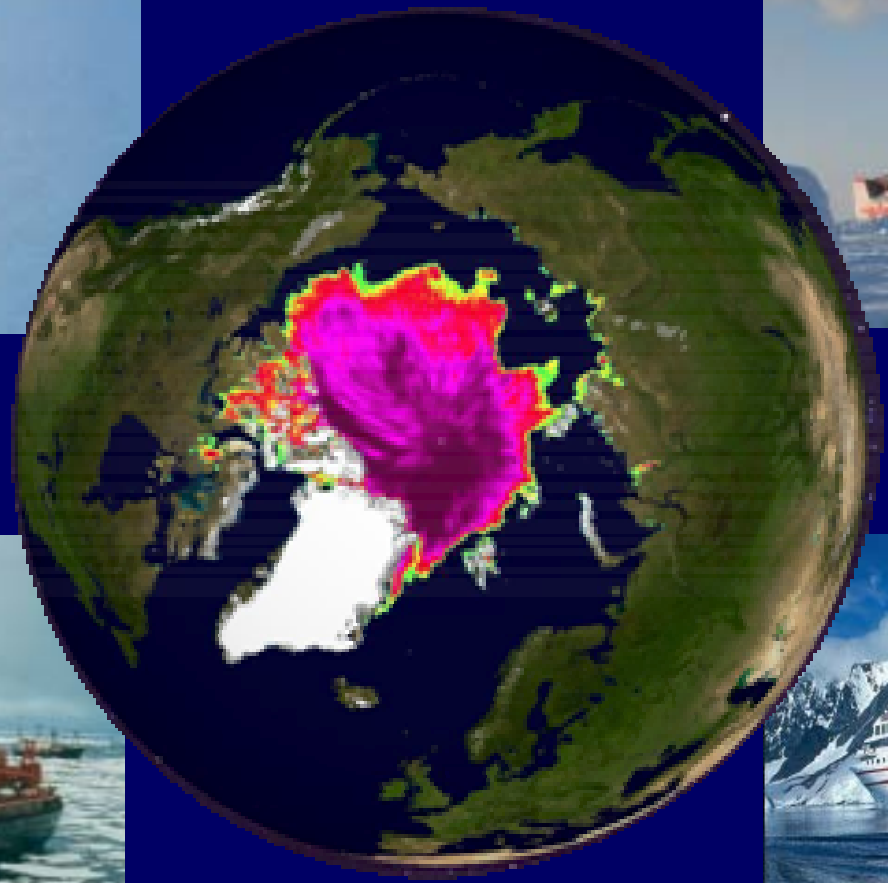
A *New* Arctic Ocean: Responding to Marine Access Change at the Top of the World

International Oil & Ice Workshop

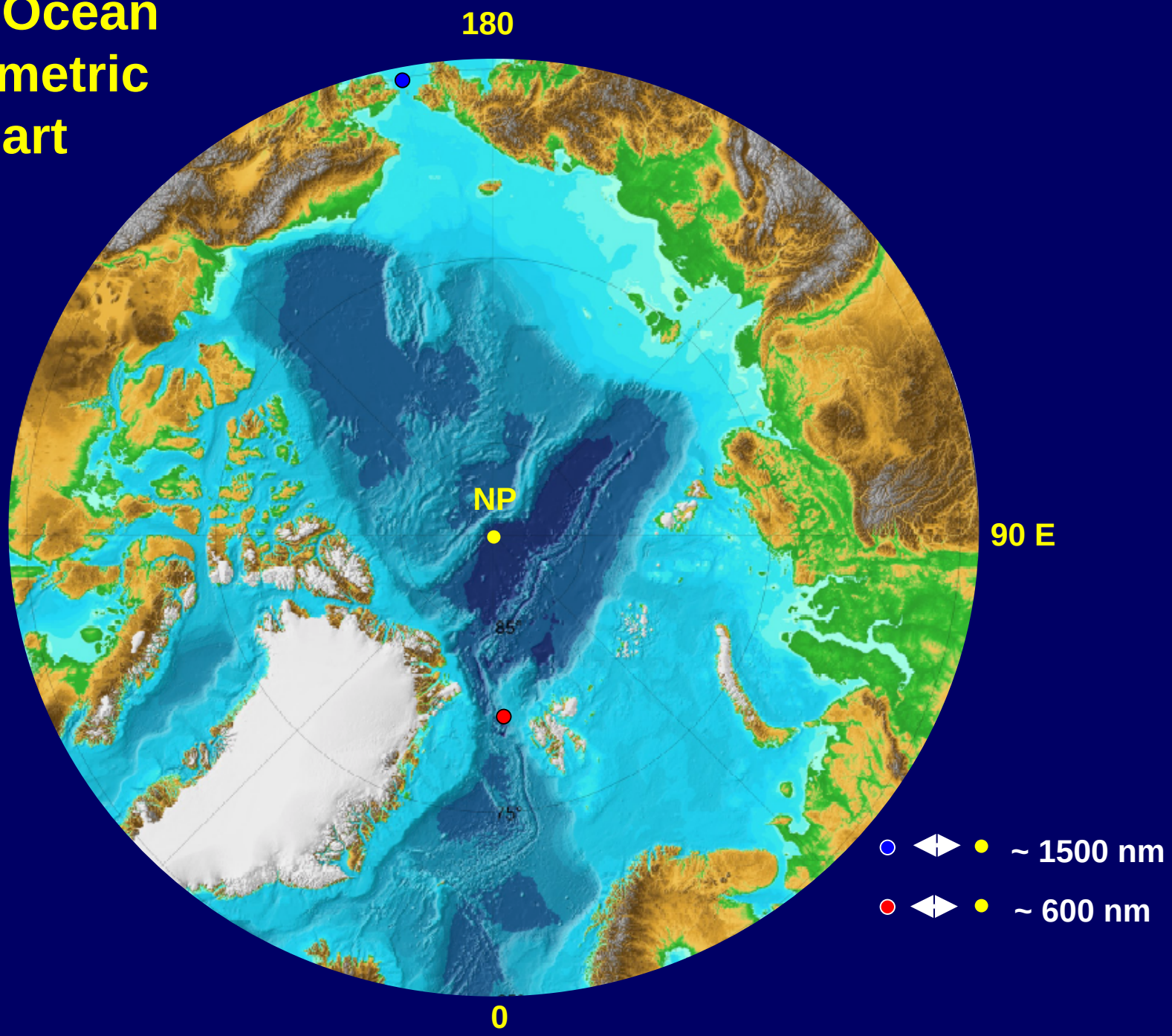
Anchorage, Alaska

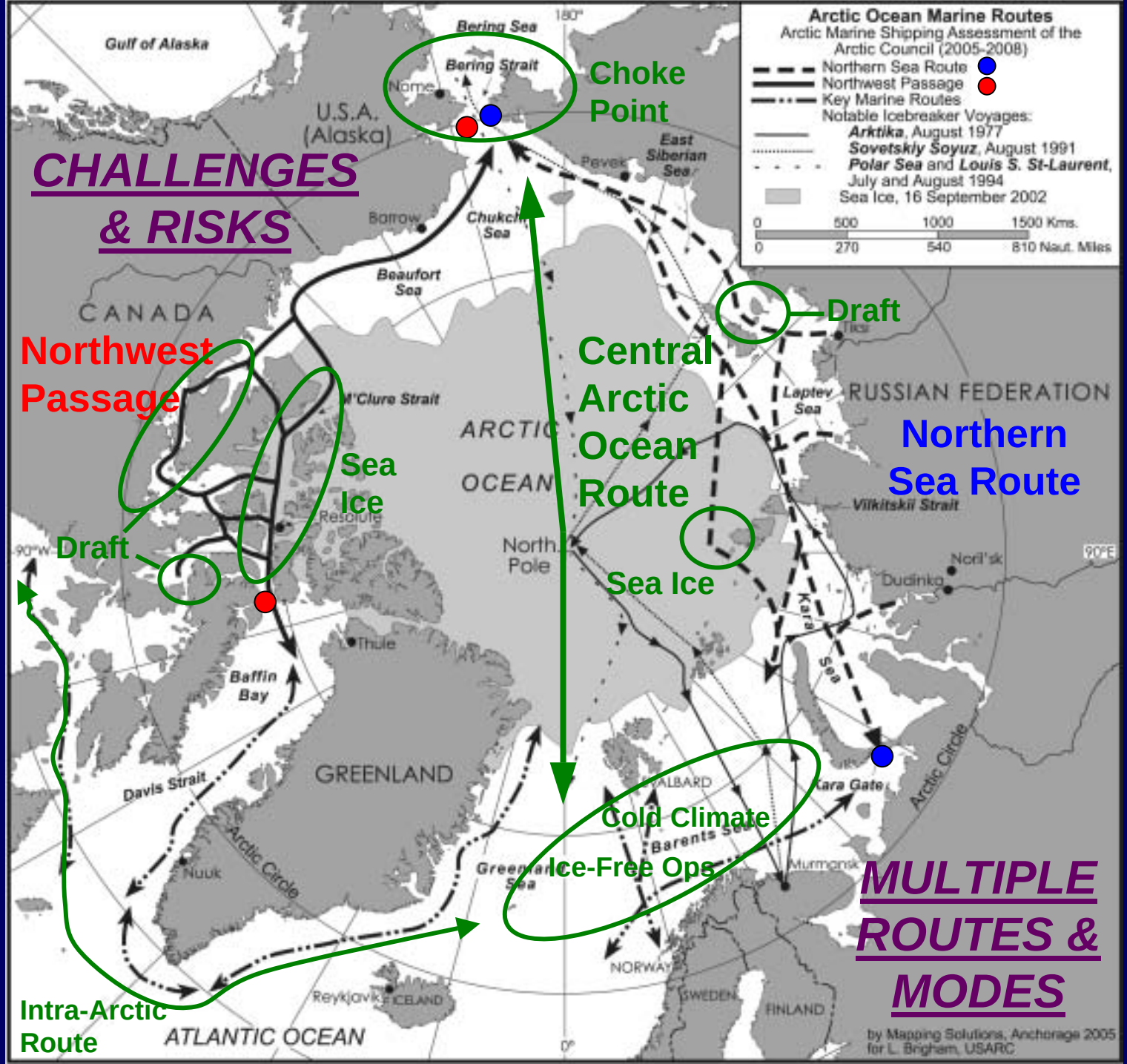
10 October 2007

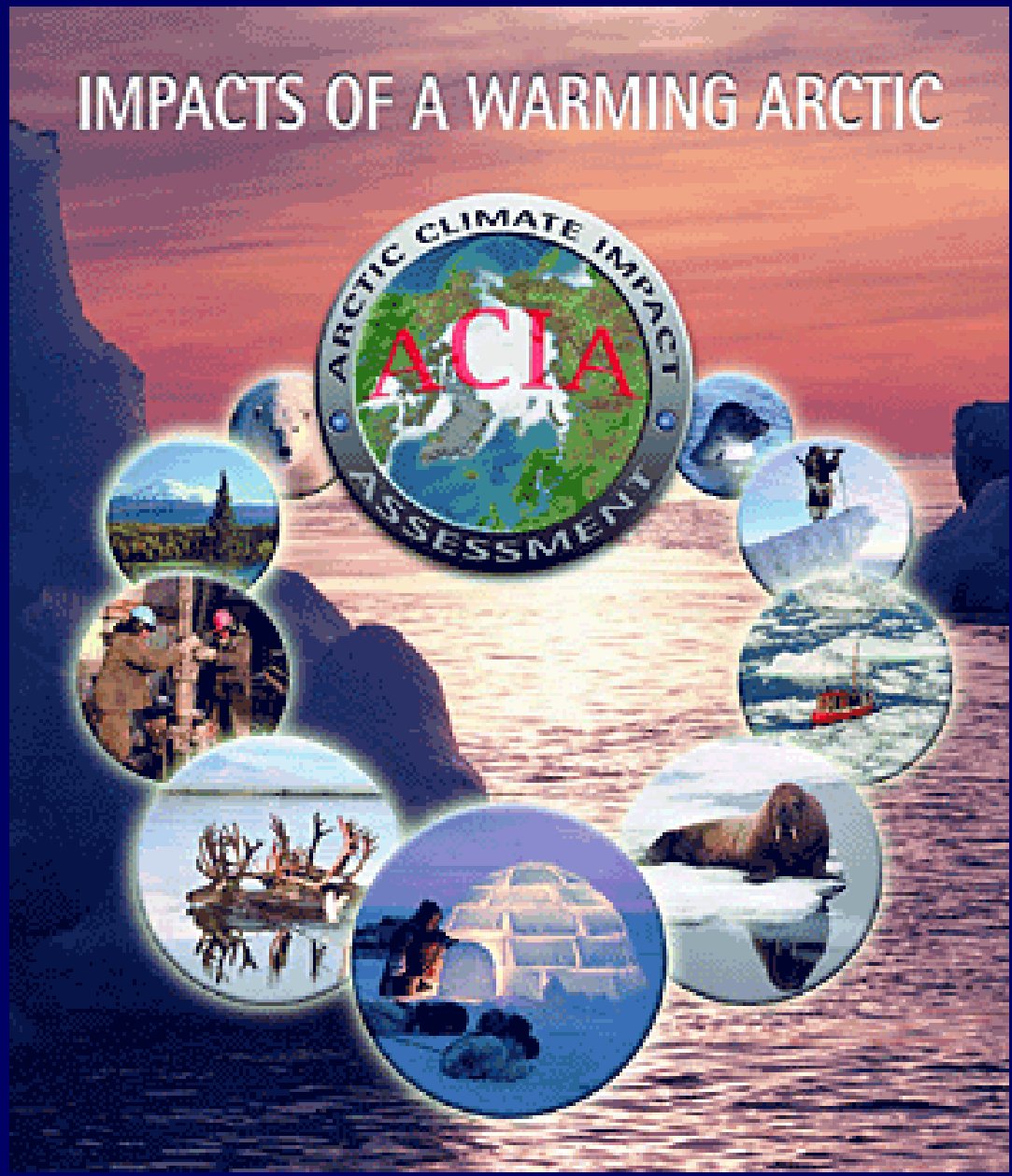


Lawson W. Brigham, PhD
Vice Chair, PAME & Chair, AMSA
U.S. Arctic Research Commission ~ Anchorage

Arctic Ocean Bathymetric Chart



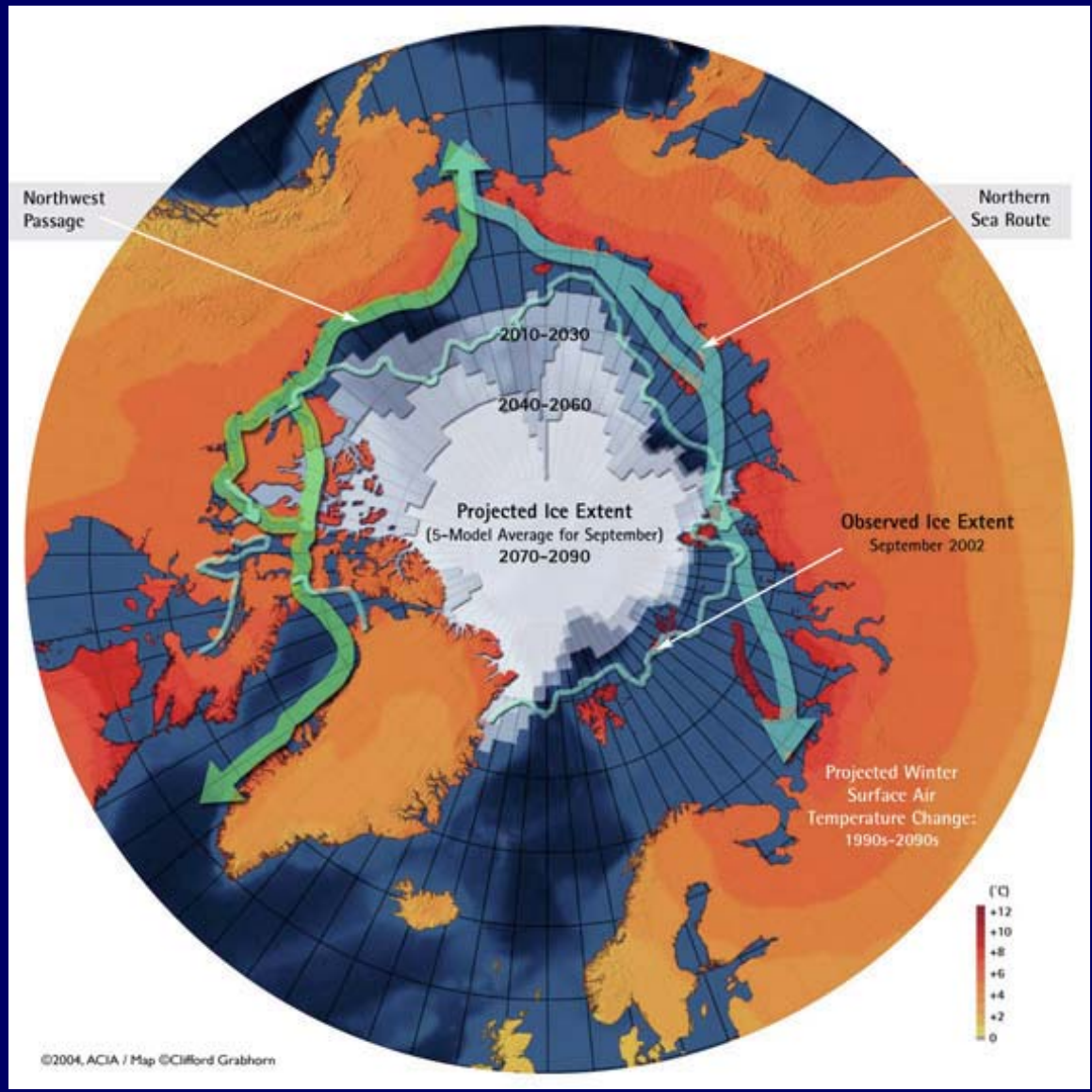

Arctic Ocean Marine Routes
Arctic Marine Shipping Assessment of the Arctic Council (2005-2008)
Northern Sea Route
Northwest Passage
Key Marine Routes
Notable Icebreaker Voyages:
Arktika, August 1977
Sovetskiy Soyuz, August 1991
Polar Sea and Louis S. St-Laurent, July and August 1994
Sea Ice, 16 September 2002
0 500 1000 1500 Kms.
0 270 540 810 Naut. Miles
CHALLENGES & RISKS
Choke Point
Draft
Central Arctic Ocean Route
Northwest Passage
Sea Ice
Draft
Sea Ice
Northern Sea Route
MULTIPLE ROUTES & MODES
Cold Climate
Ice-Free Ops
Intra-Arctic Route
Gulf of Alaska
Bering Sea
Bering Strait
Nome
U.S.A. (Alaska)
East Siberian Sea
Pevek
Barrow
Chukchi Sea
Beaufort Sea
CANADA
RUSSIAN FEDERATION
Laptev Sea
Vilkitskii Strait
ARCTIC OCEAN
North Pole
Resolute
Thule
Baffin Bay
Davis Strait
GREENLAND
Nuuk
Arctic Circle
Dudinka
Noril'sk
Kara Sea
Kara Gate
SVALBARD
Barents Sea
Murmansk
NORWAY
SWEDEN
FINLAND
Reykjavik
ICELAND
ATLANTIC OCEAN
by Mapping Solutions, Anchorage 2005 for L. Brigham, USARC


IMPACTS OF A WARMING ARCTIC
ARCTIC CLIMATE IMPACT
ACIA
ASSESSMENT

www.amap.no

Arctic Climate Impact Assessment

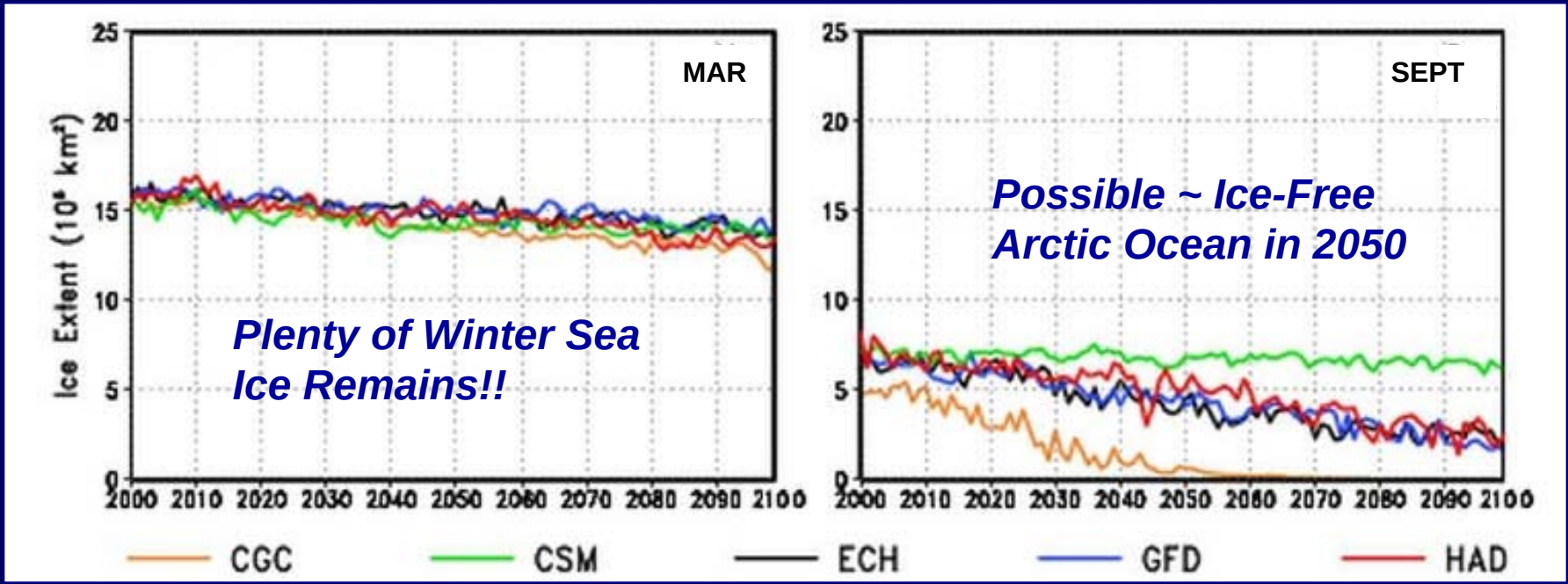
Key Finding #6: "Reduced sea ice is very likely to increase marine transport and access to resources."



Arctic Climate Impact Assessment

Climate model projections of sea ice extent: 2000 - 2100

March **September**

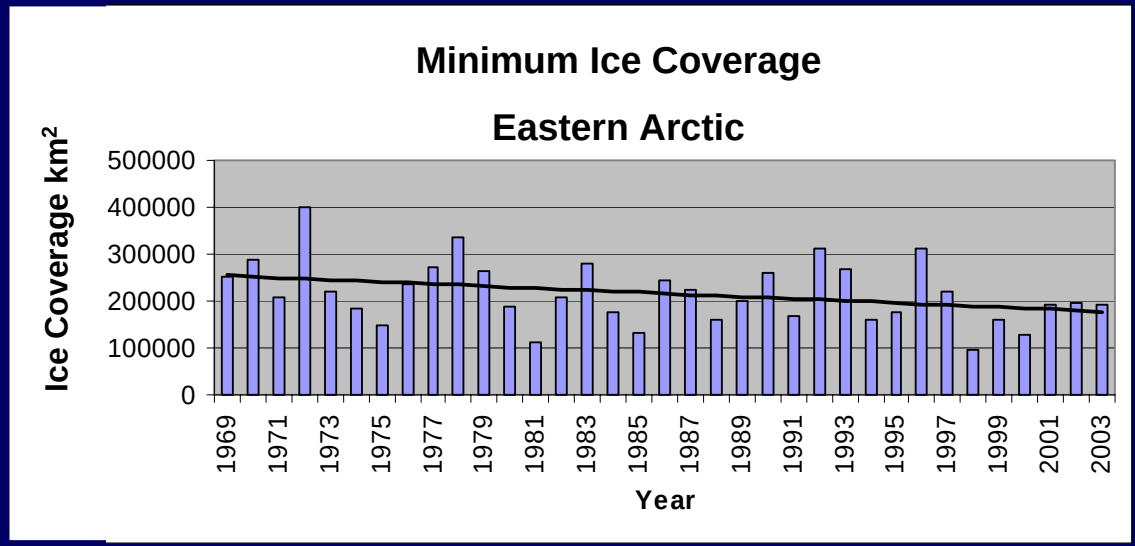


B2 IPCC Moderate Global Scenario

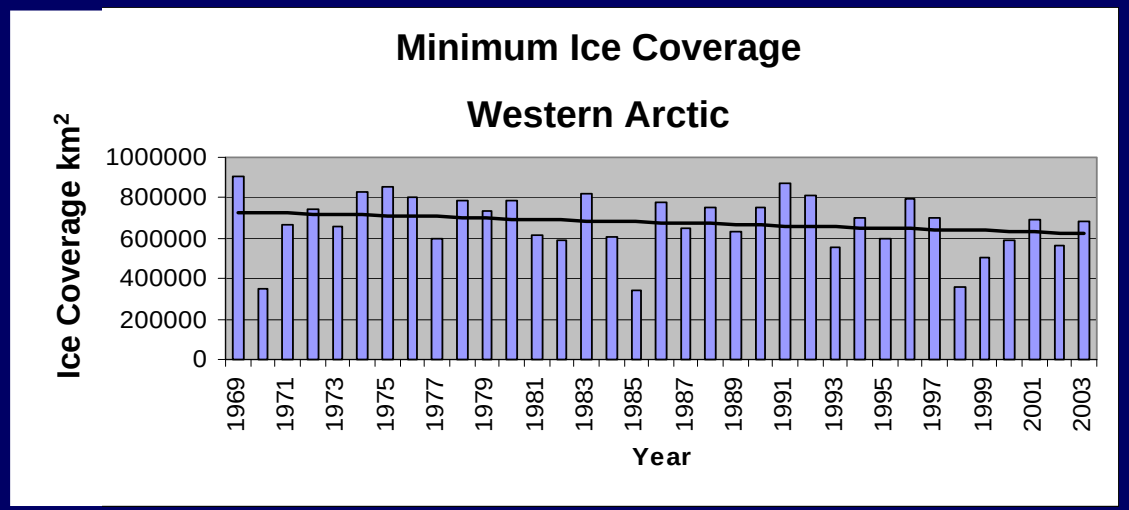
ACIA and the Northwest Passage

- Loss of Sea Ice Coverage
- Large Inter-annual Variability

Regional Eastern Arctic



Regional Western Arctic



Canadian Ice Service (2004)

Arctic Council, PAME-led Arctic Marine Shipping Assessment

- *Lead Countries*: Canada, Finland, and USA
- *Key Countries & Regions*: Norway & Russia (Norwegian-Barents-Kara seas), Iceland, Denmark-Greenland-Faroe Islands, Sweden
- *Timeline*: 2005 – 2009 (*Completion Spring 2009*)
- *Electronic Survey Questionnaire* ~ Sent to SAOs Jan 2006; Continuing 2004 Data Collection from the Arctic States
- *Inclusive Participation*: Member States, Permanent Participants, Council Working Groups; Council Observers; Shipping Industry; Ship Classification Societies; Research Organizations; Others ~ *Key Challenge: Many Non-Arctic Stakeholders*

PAME

Arctic Marine Vessel Activity ~ AMSA Ship Types

Tankers ~ Bulk Carriers
Container Ships ~Tug-Barge Combinations
Fishing Vessels ~ Ferries ~ Passenger Vessels/Cruise Ships
Research Vessels ~ Offshore Supply Vessels
Icebreakers (Government & Commercial) ~ Others

Icebreaker Transits to the North Pole & Trans-Arctic Voyages (1977-2007):

- **72 Transits to the North Pole (60 Russia, 5 Sweden, 3 USA, 2 Germany, 1 Canada, 1 Norway)**
- **Single Non-summer NP Voyage (*Sibir* Voyage May-June 1987)**
- **28 Ship Transits to the NP in 2004-2007**
- **7 Trans-Arctic Voyages (1991, 1994, 1996, 2005)**

25 May 1987
Soviet Nuclear Icebreaker *Sibir*
'A Walk Around the World!'

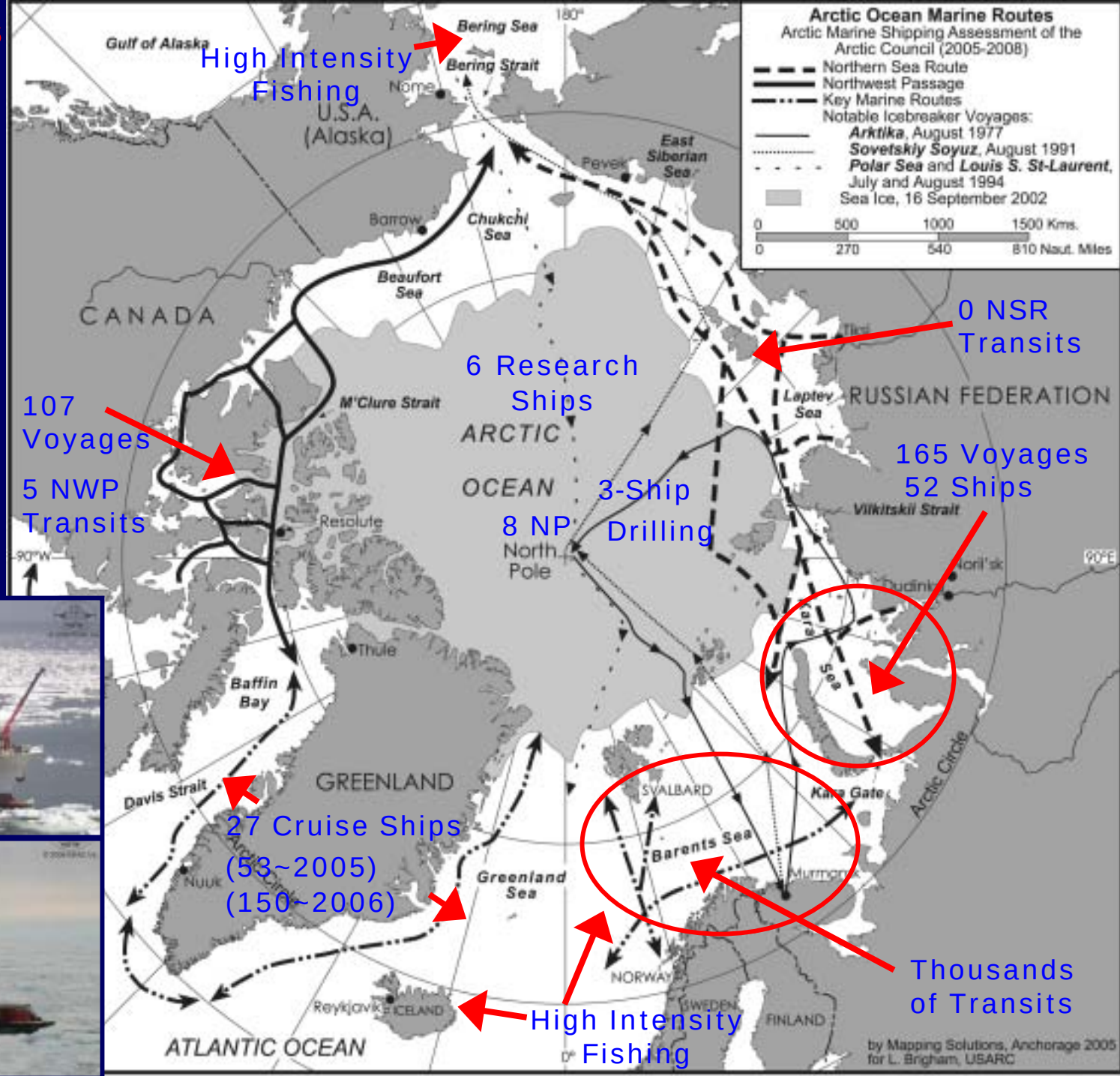
***ARKTIKA*'s Historic 1977 North Pole Voyage**

How Many Ships in the Arctic?

Snapshot of Summer 2004 Traffic

Modes of Arctic Marine Transport

- **Destinational / Regional**
- **Trans-Arctic**
- **Trans-Arctic with Transshipment**
- **Intra-Arctic**



Annual Traffic: Northern Sea Route (thousand tons)

1970 – 2980

1980 – 4952

1985 – 6181

1987 – 6579 (max)

1990 – 5510

1995 – 2362

2000 – 1587

2003 – 1700

NSR Ships & Voyages

1987 – 331, 1306

1990 – 252 , 886

1995 – 134 , 309

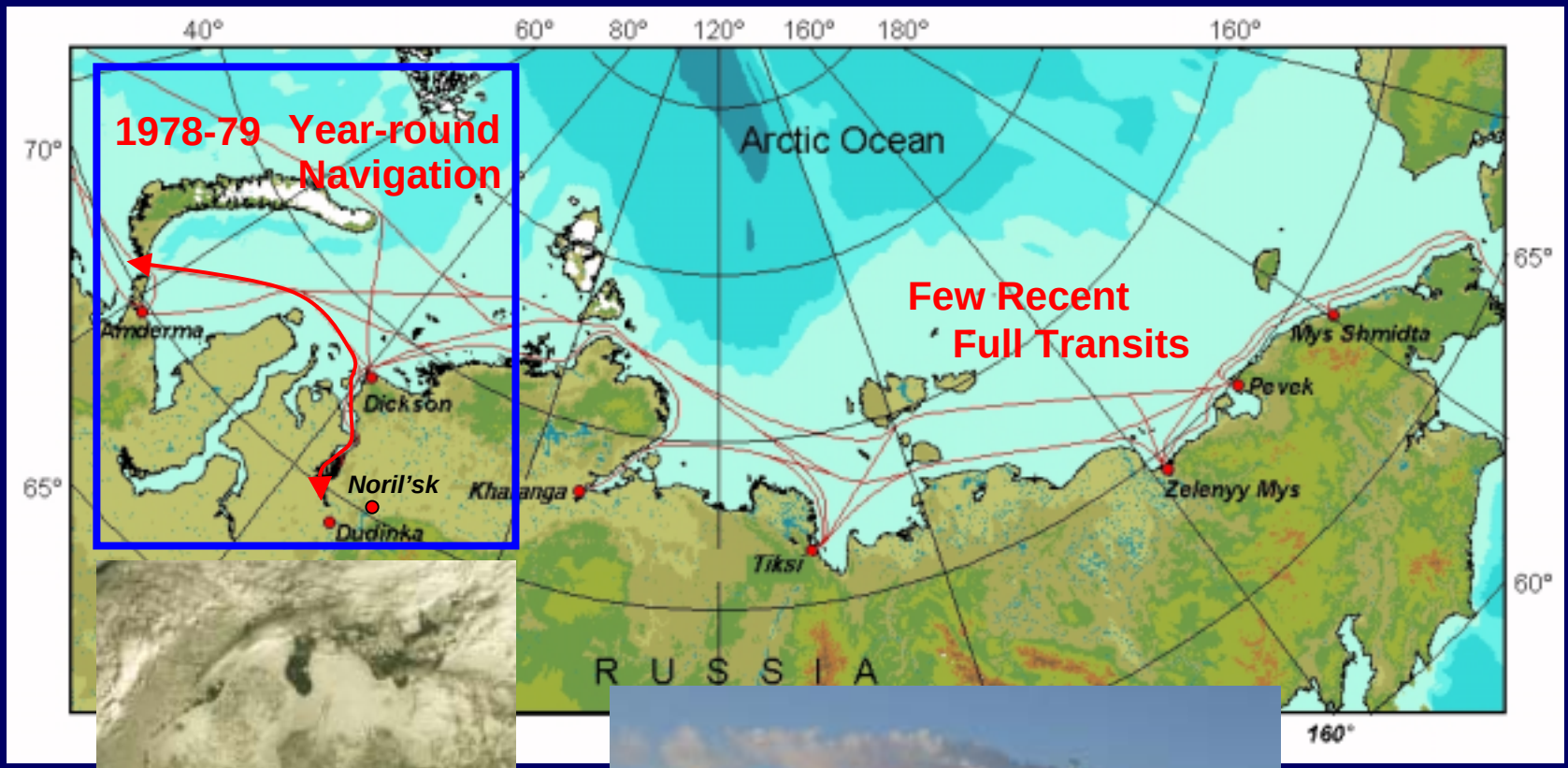
2000 – 52 , 169

2003 – 47, 160

SA-I5 Icebreaking Carrier

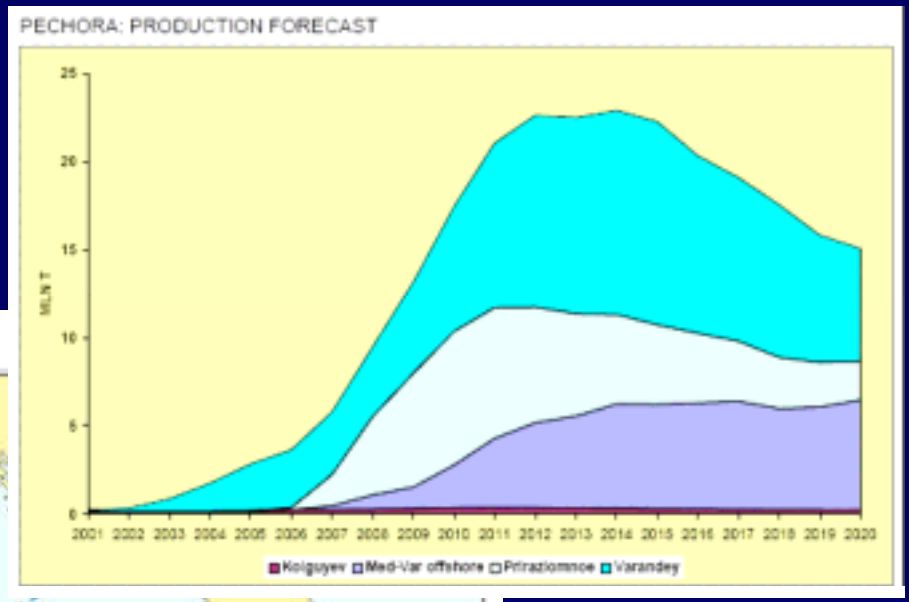
Murmansk Shipping Company

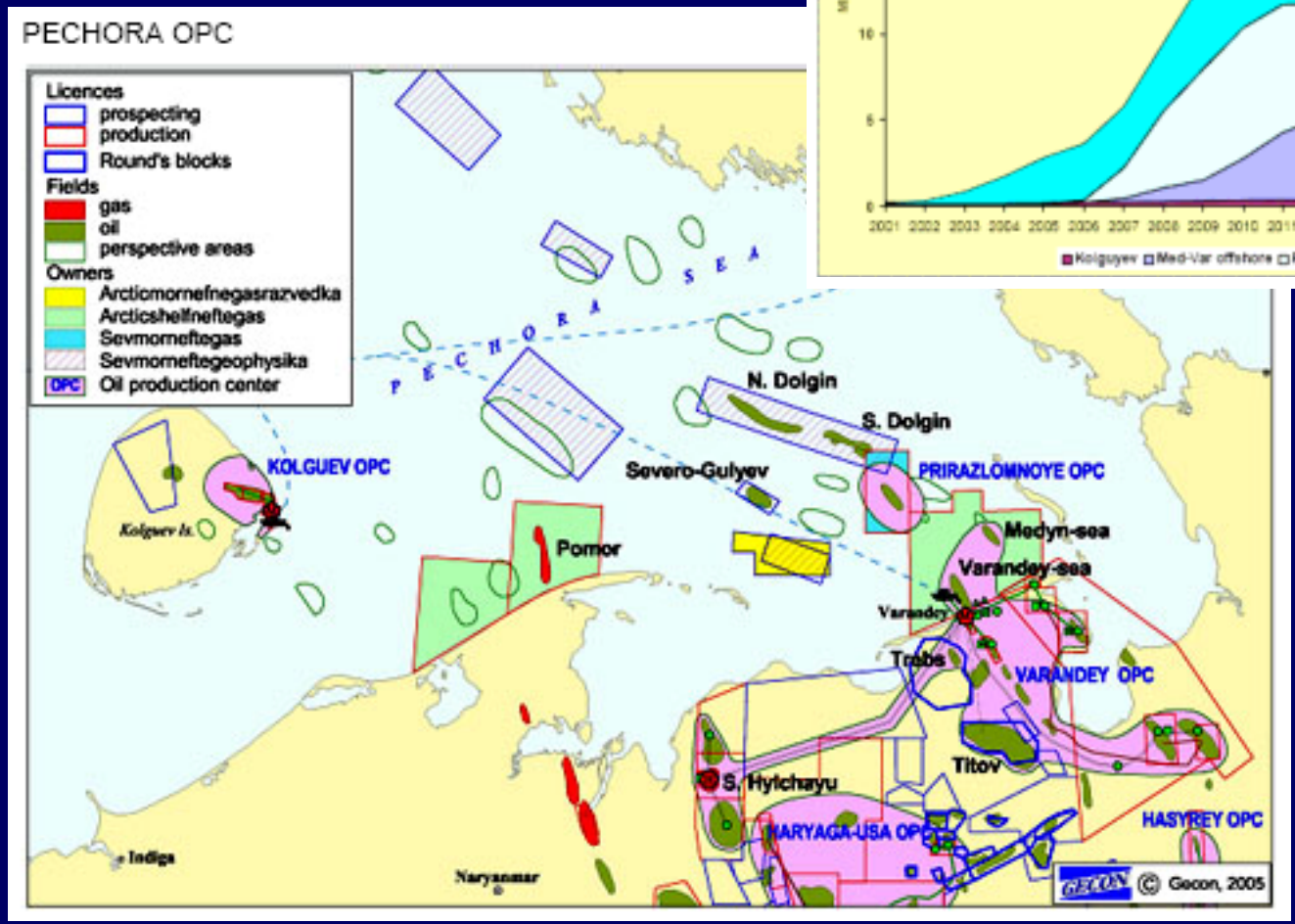
The Northern Sea Route



INSROP (1999)

Pechora Development





Future Varandey Arctic Marine Transport System

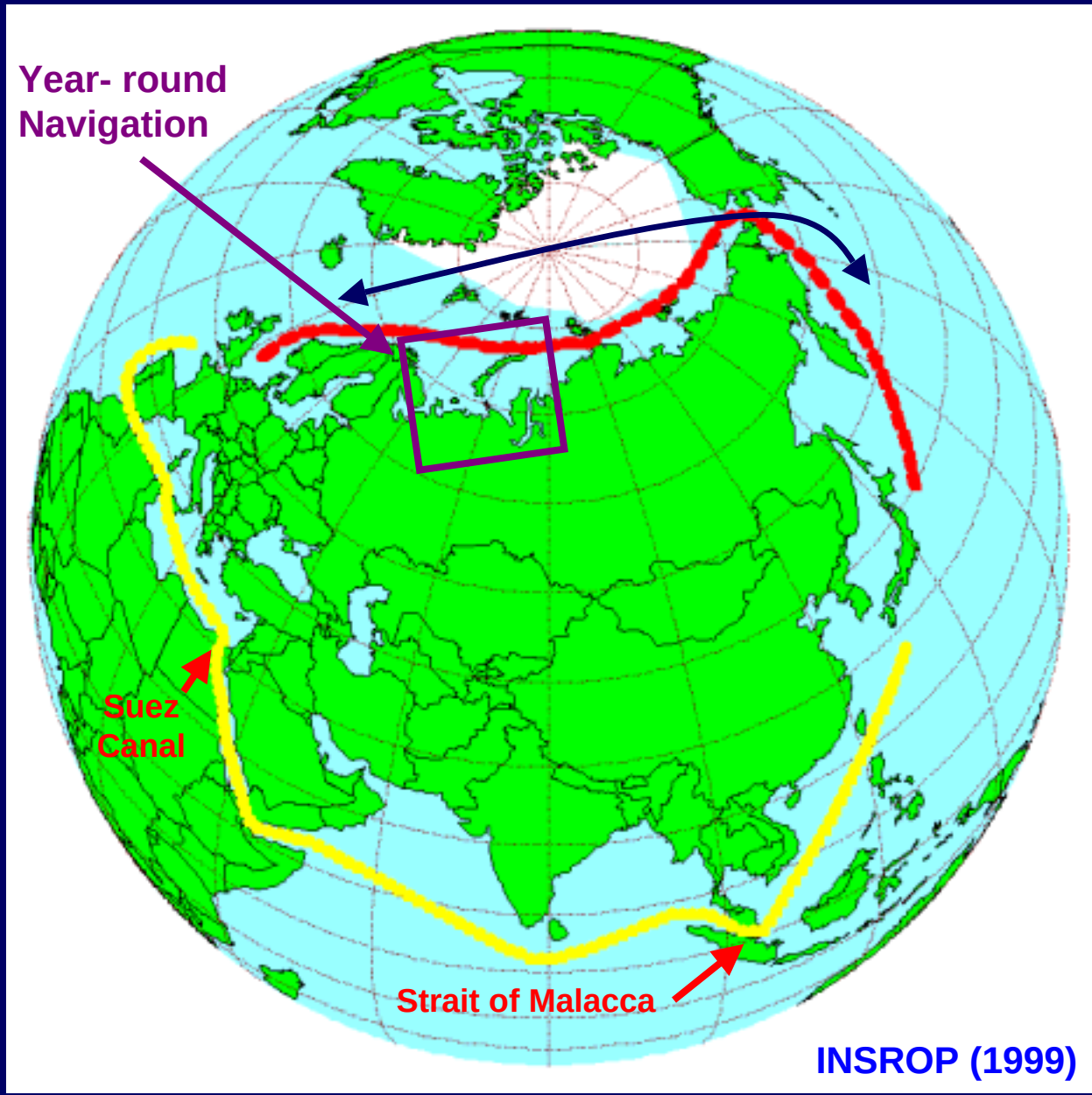
Distance (Nautical Miles)
Hamburg to Yokohama

Northern Sea Route ~ 6,920

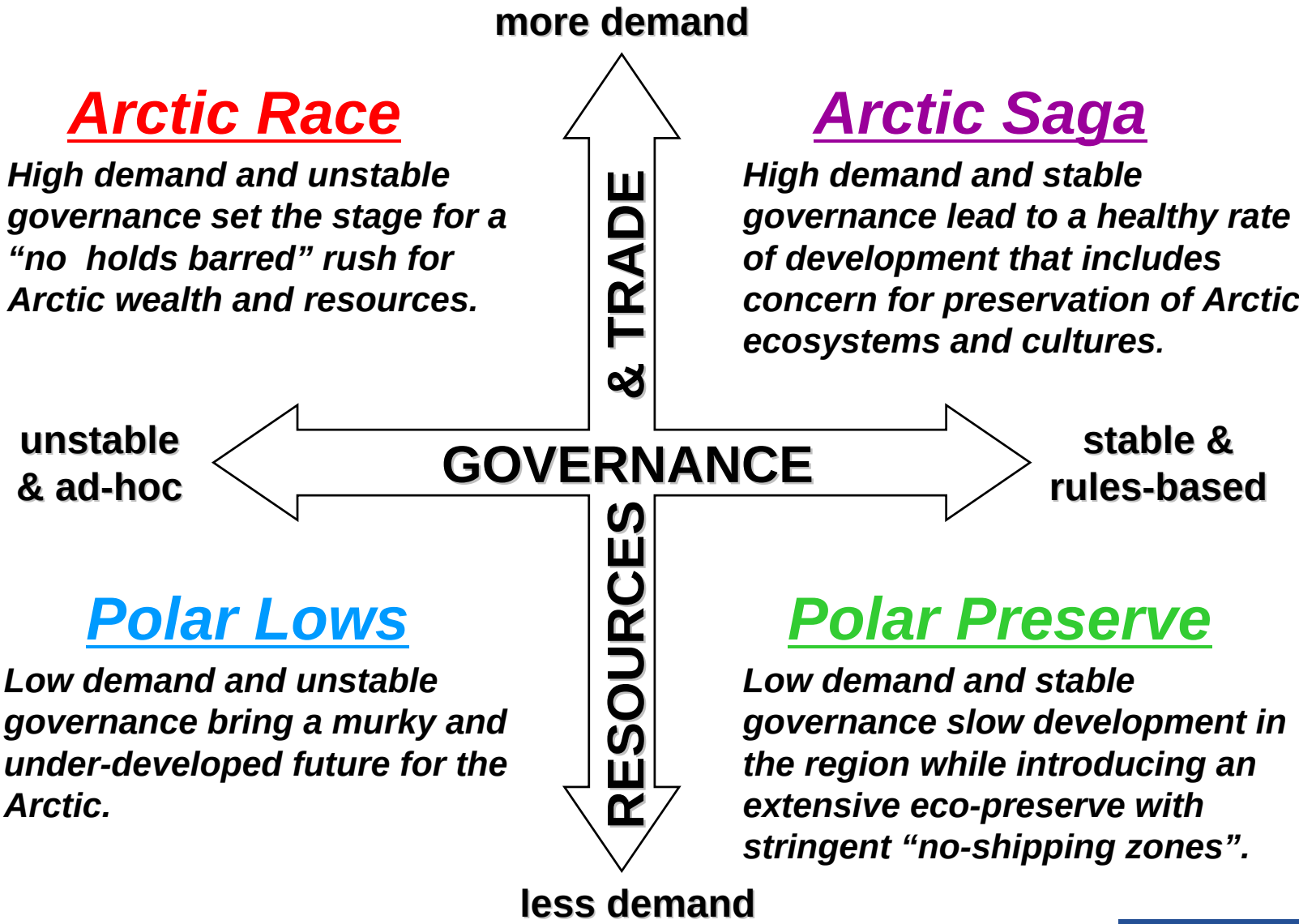
Suez Canal ~ 11,073

Panama Canal ~ 12,420

Cape of Good Hope ~ 14,542

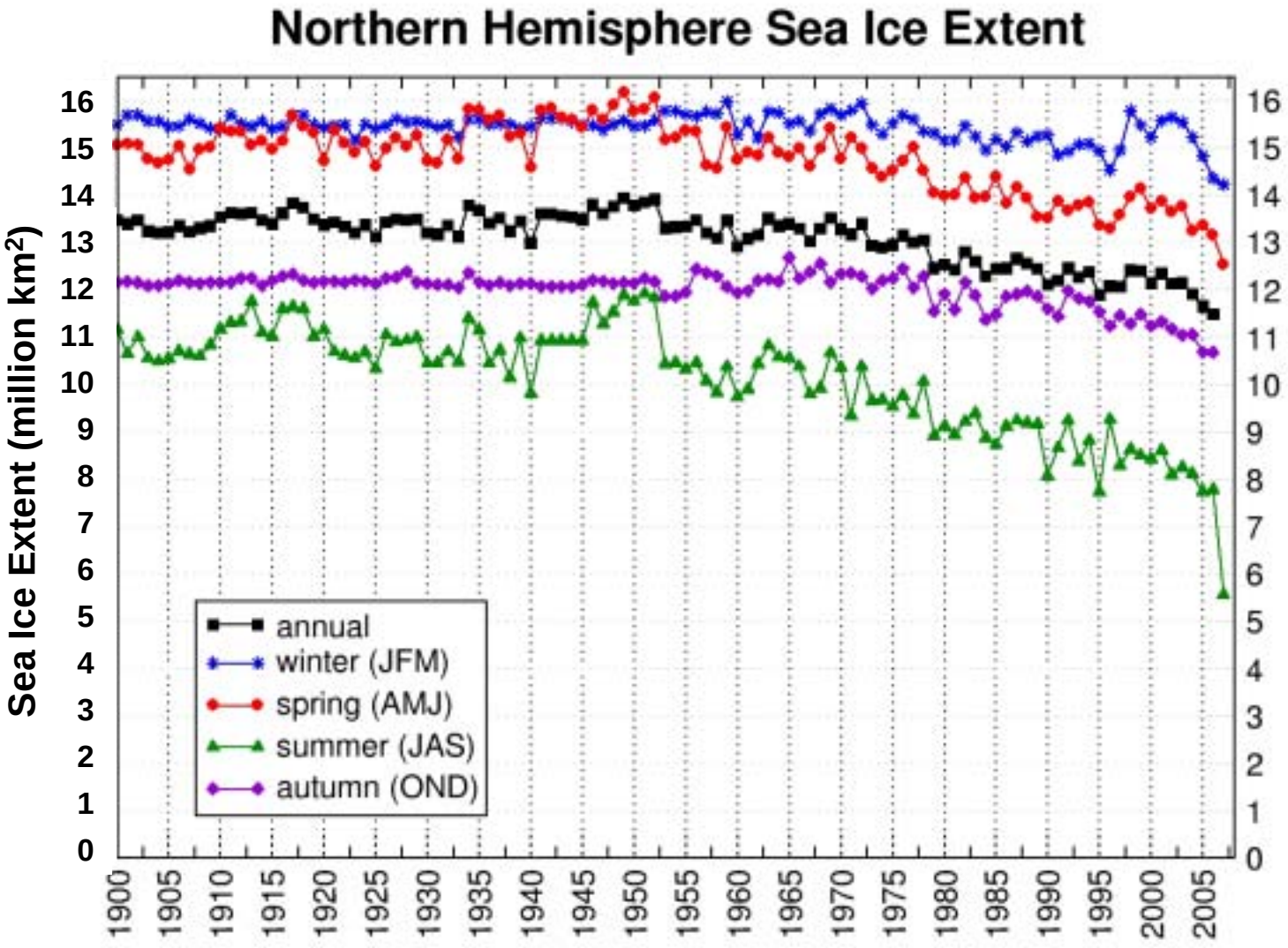


Scenarios on the Future of Arctic Marine Navigation in 2050



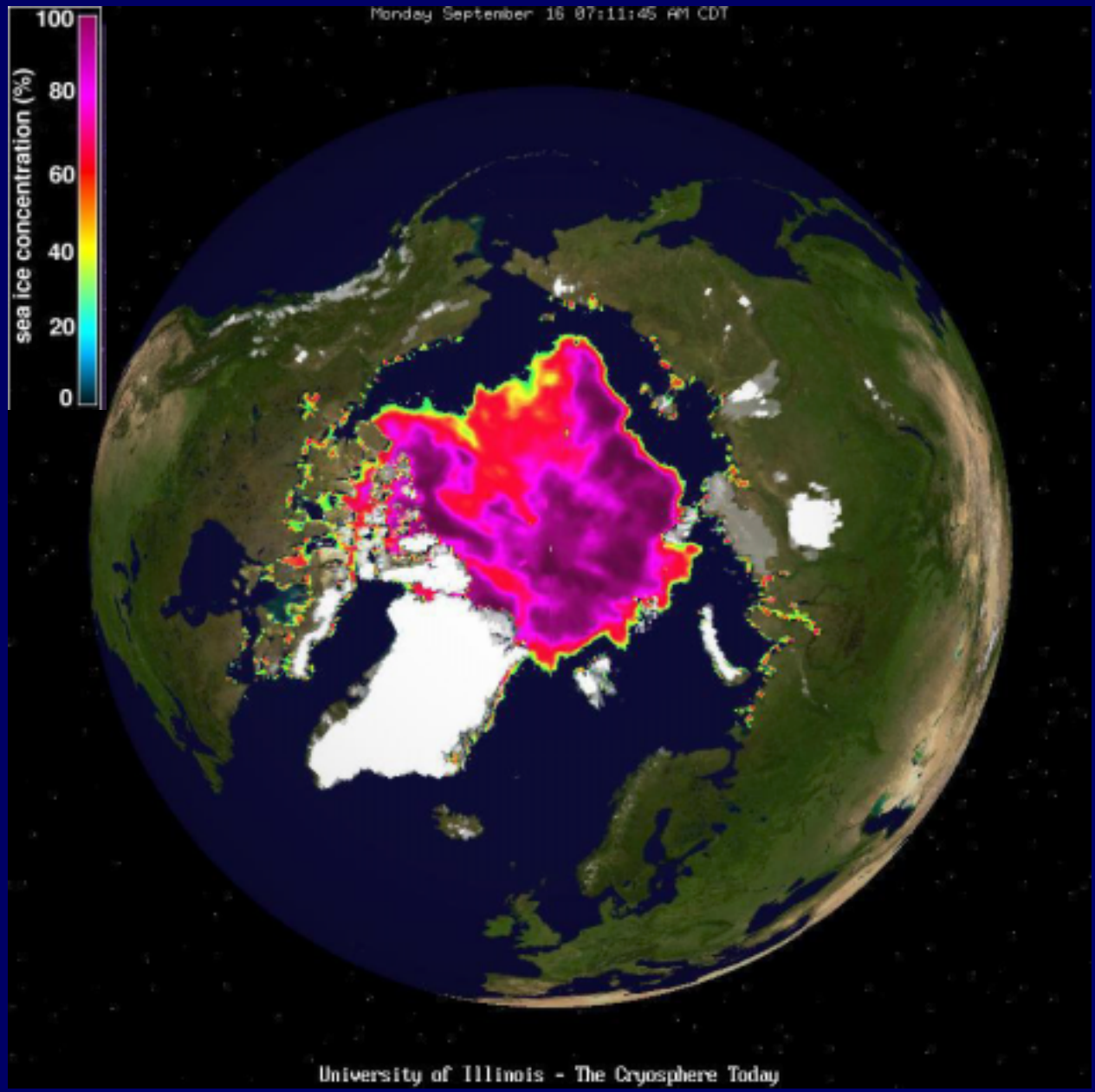
Sea Ice

- Extent decrease is largest during summer
- Extent decrease is largest since late 1980s
- Extent seasonal decreases since 1950s

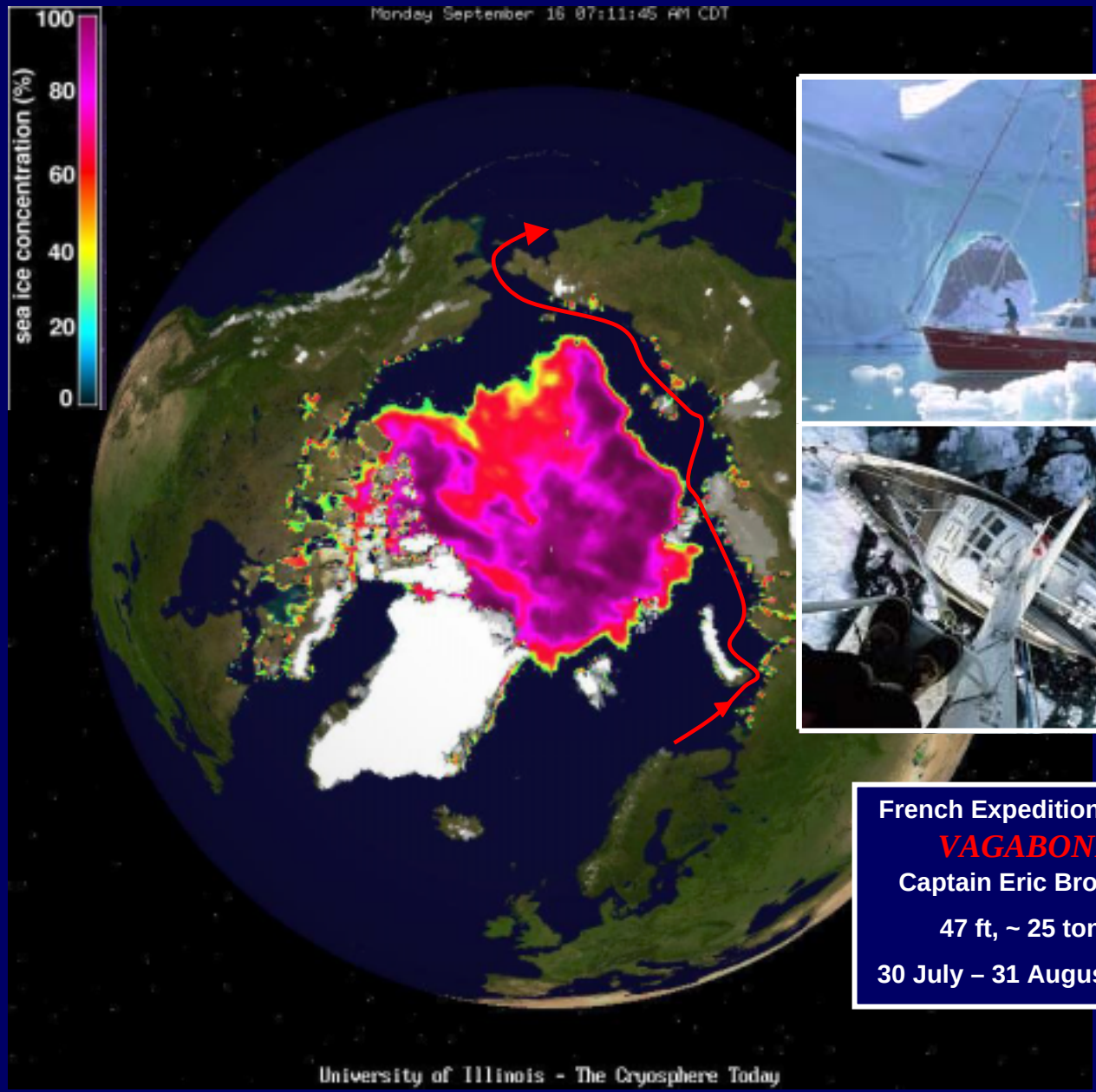


Chapman & Walsh (2003)

16 September 2002



16 September 2002



French Expedition Yacht

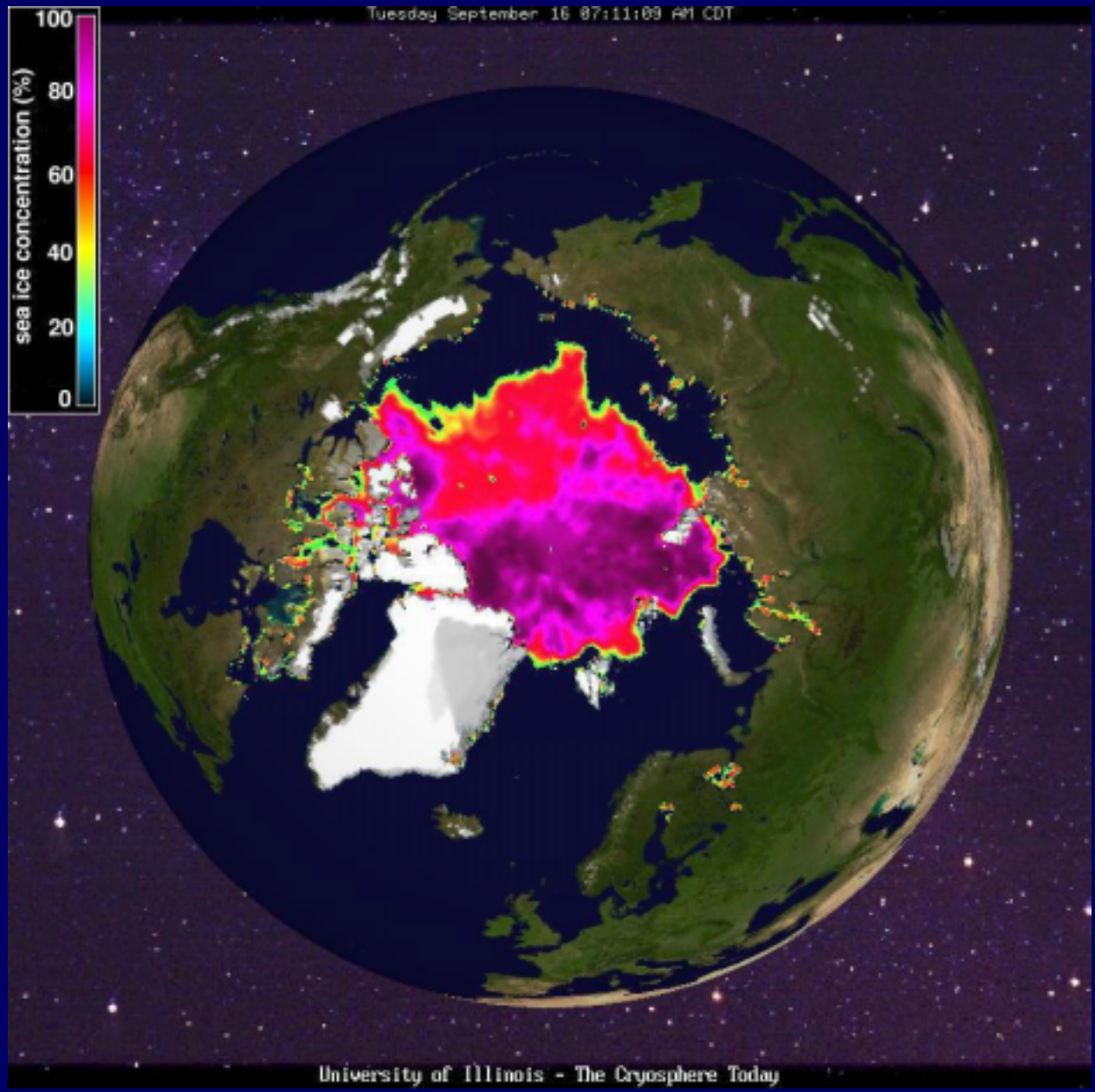
VAGABOND

Captain Eric Brossier

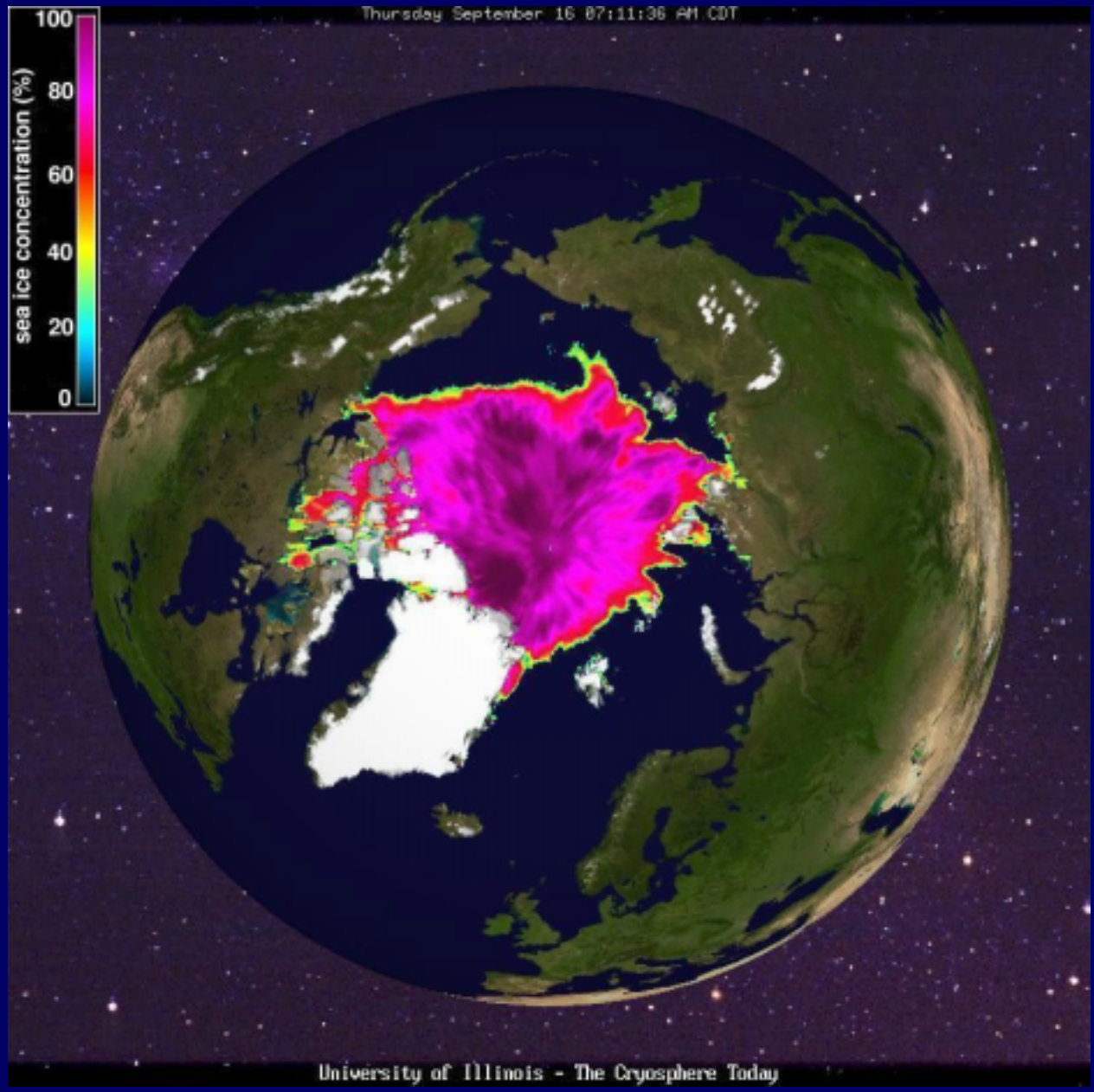
47 ft, ~ 25 tons

30 July – 31 August 2002

16 September 2003

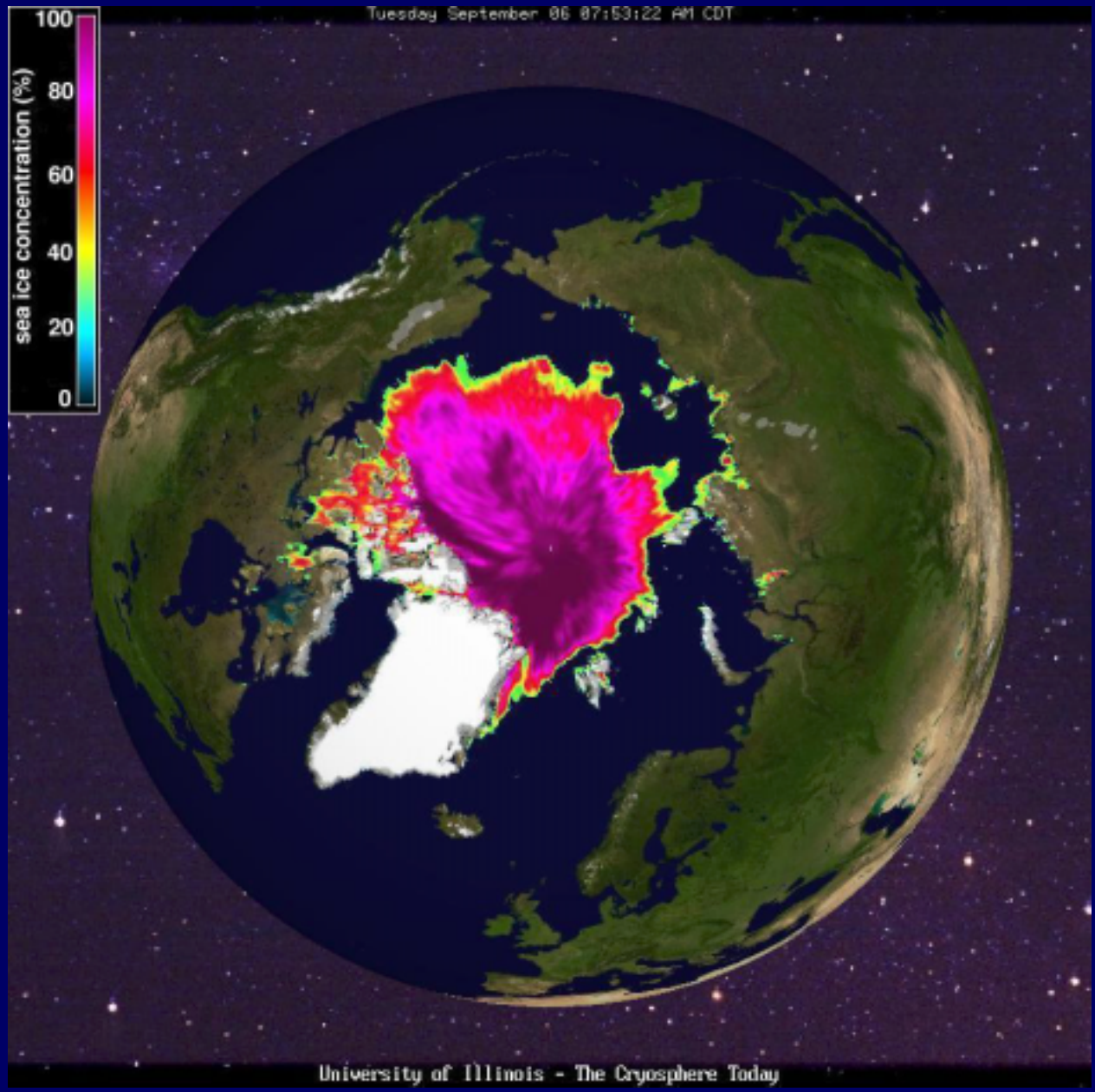


16 September 2004

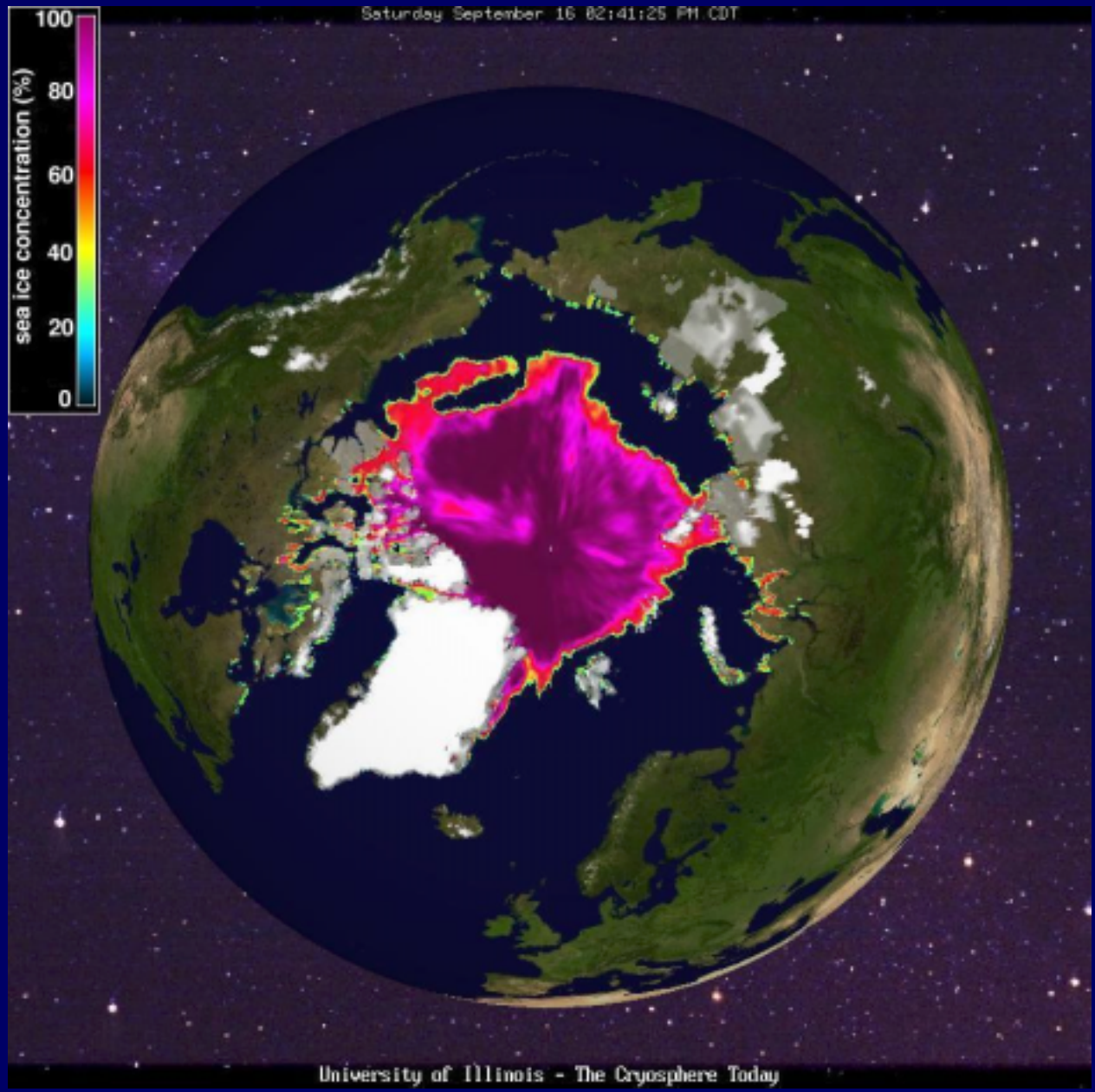


6 September 2005

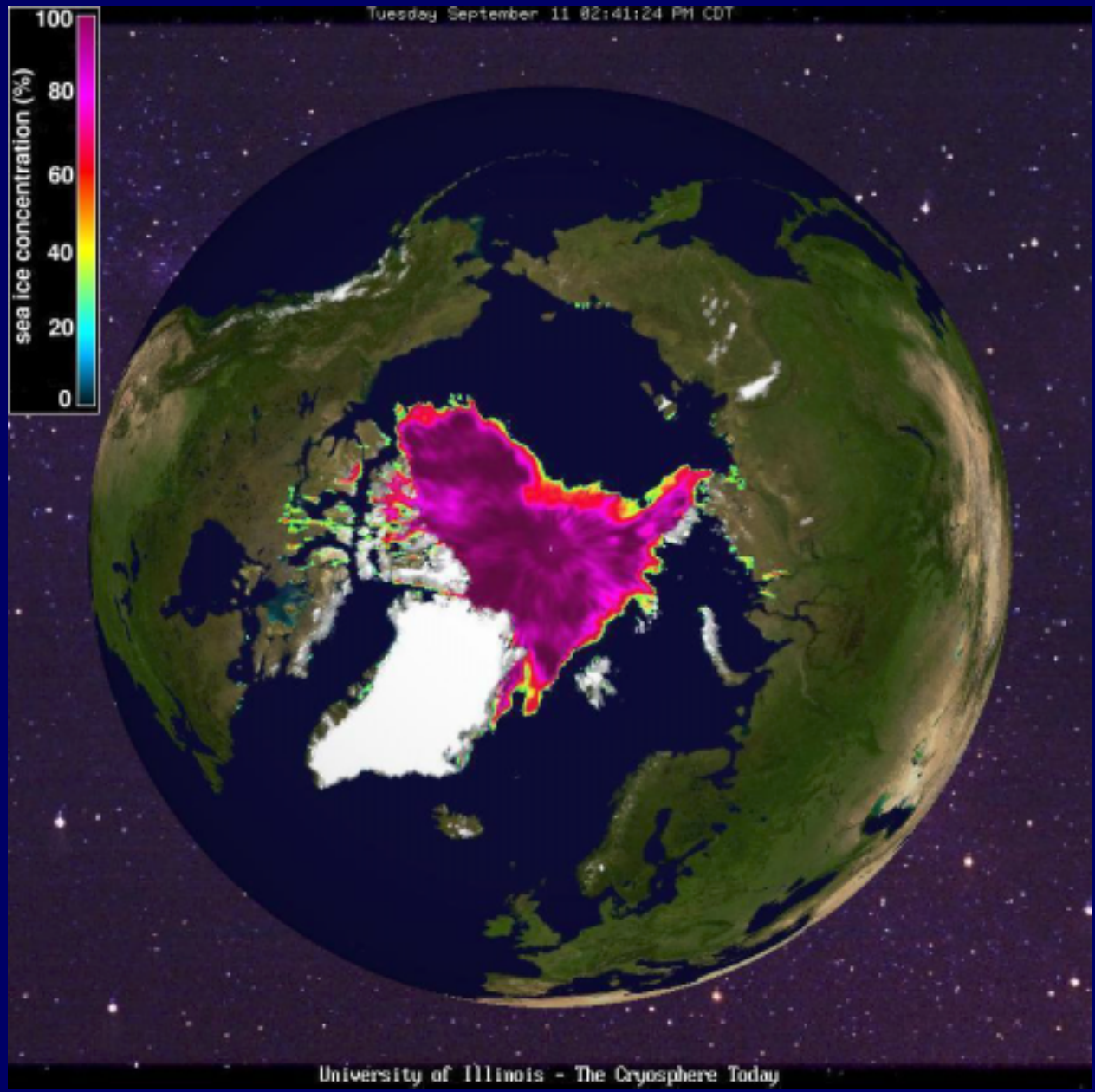
Previous Historic Minimum Arctic Sea Ice Extent



16 September 2006



11 September 2007



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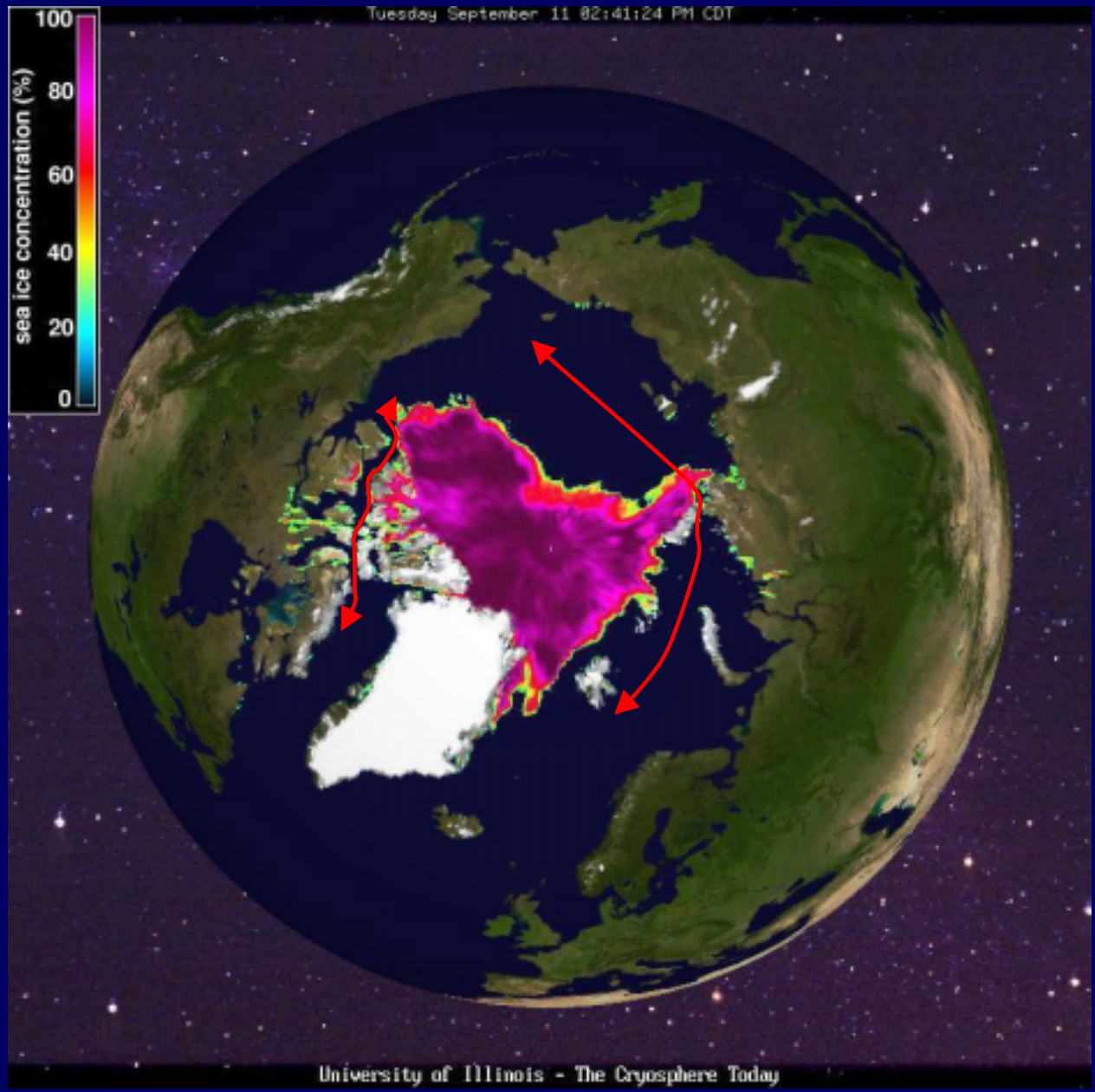

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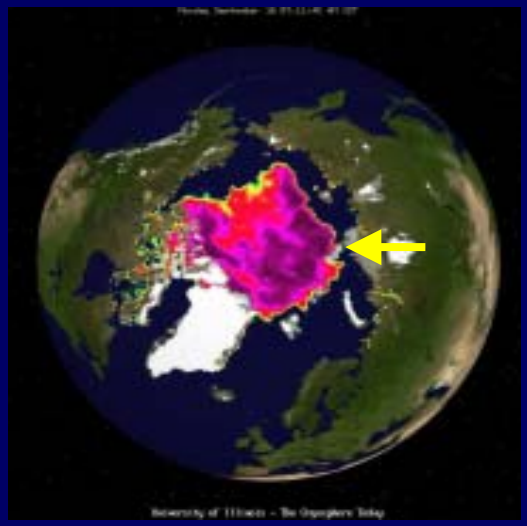

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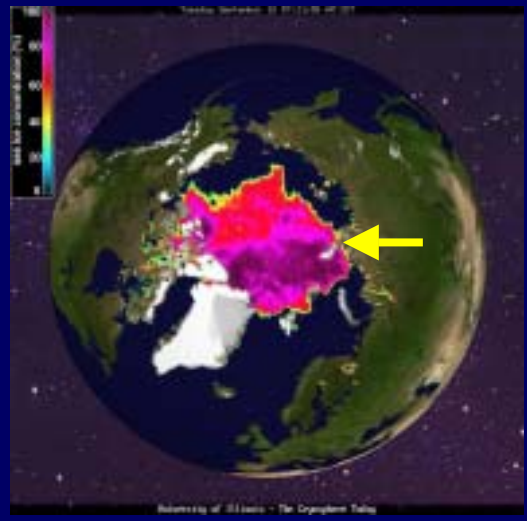

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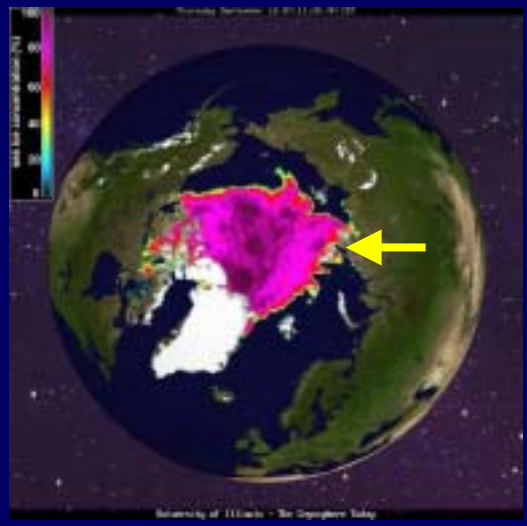
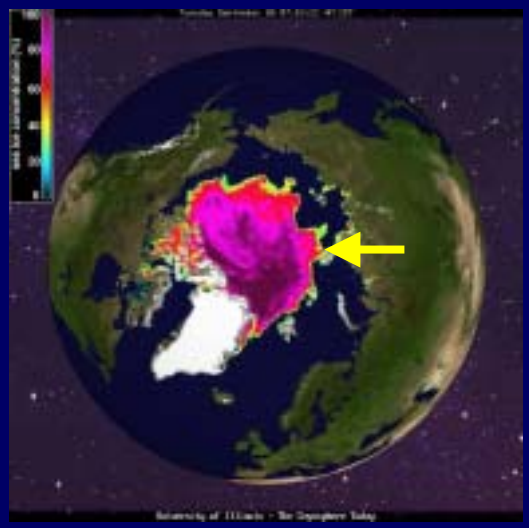
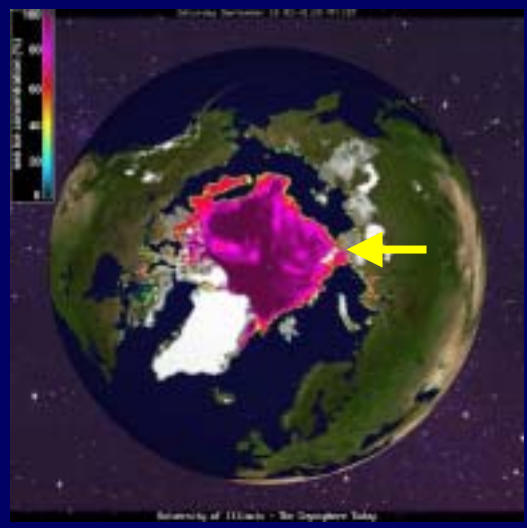




6 September 2005



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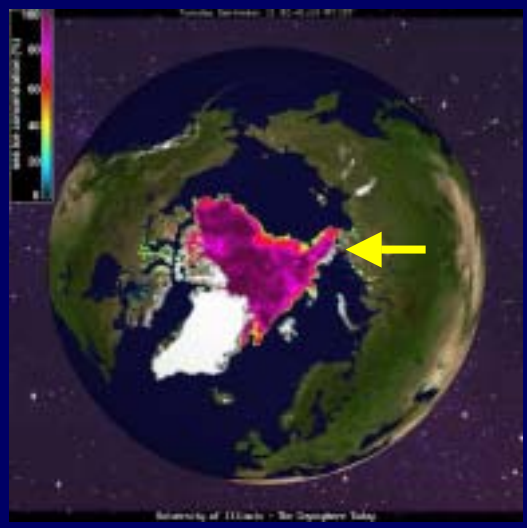
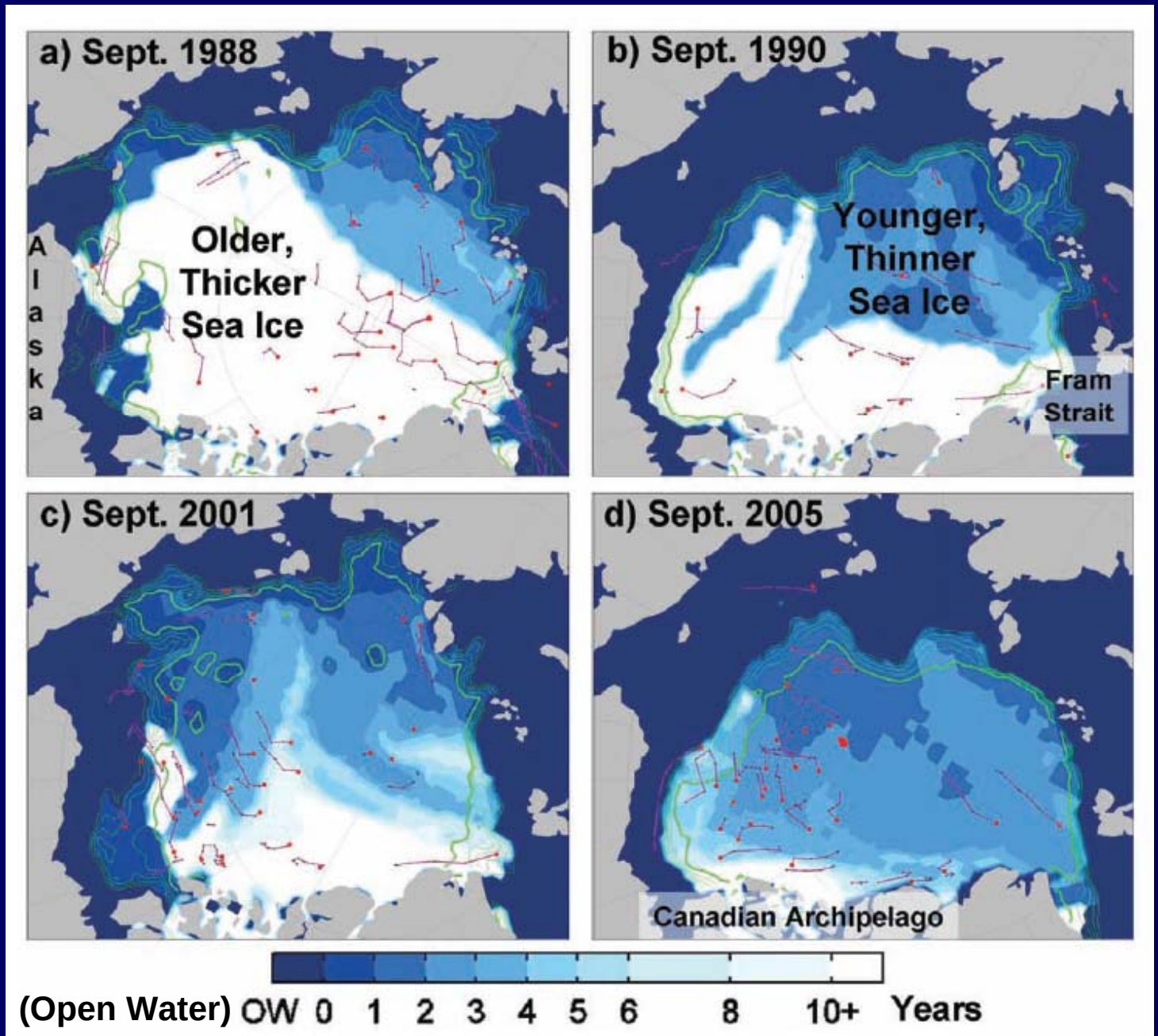
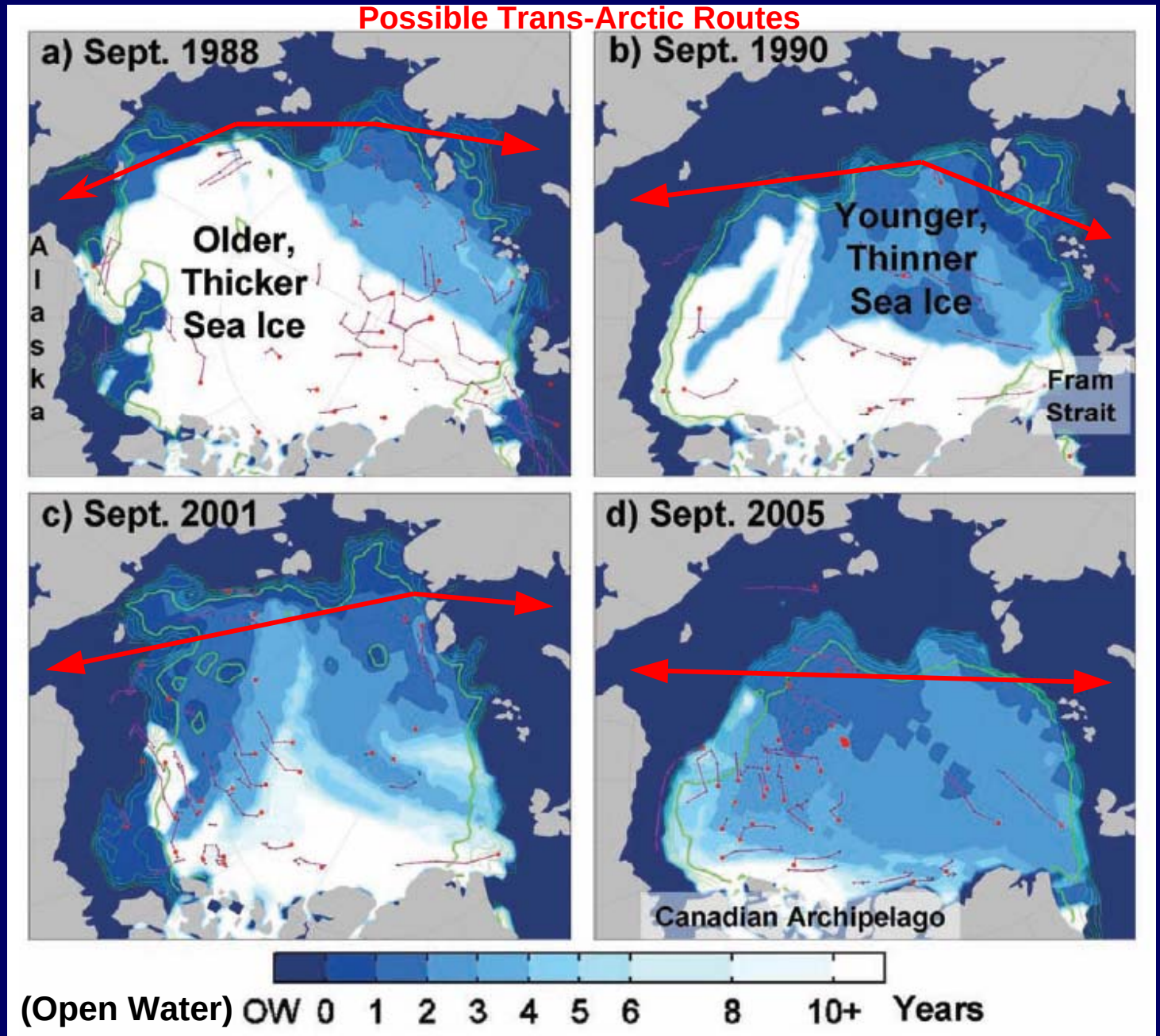


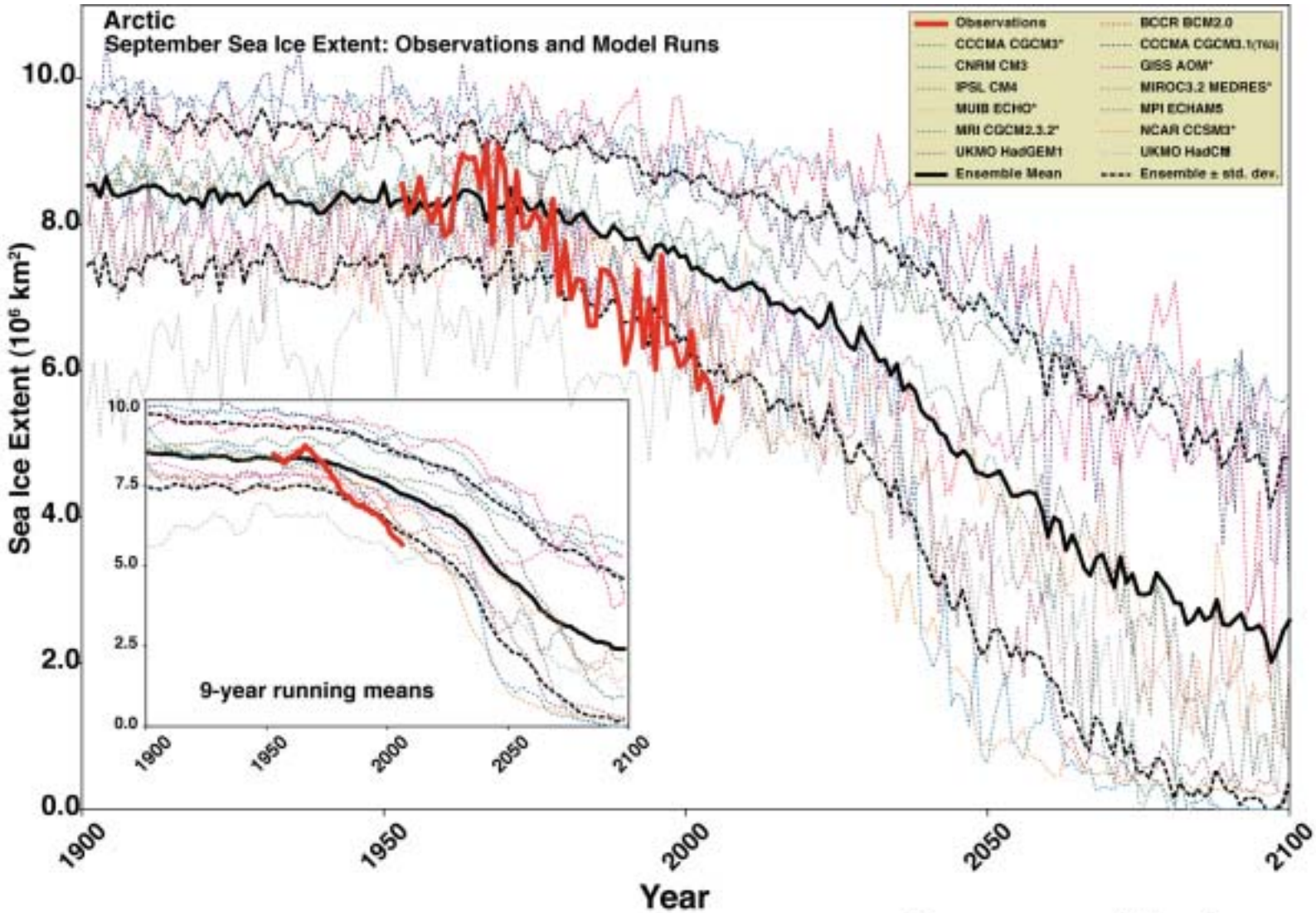
11 September 2007

Changing Nature of Multi-year Arctic Sea Ice



Changing Nature of Multi-year Arctic Sea Ice



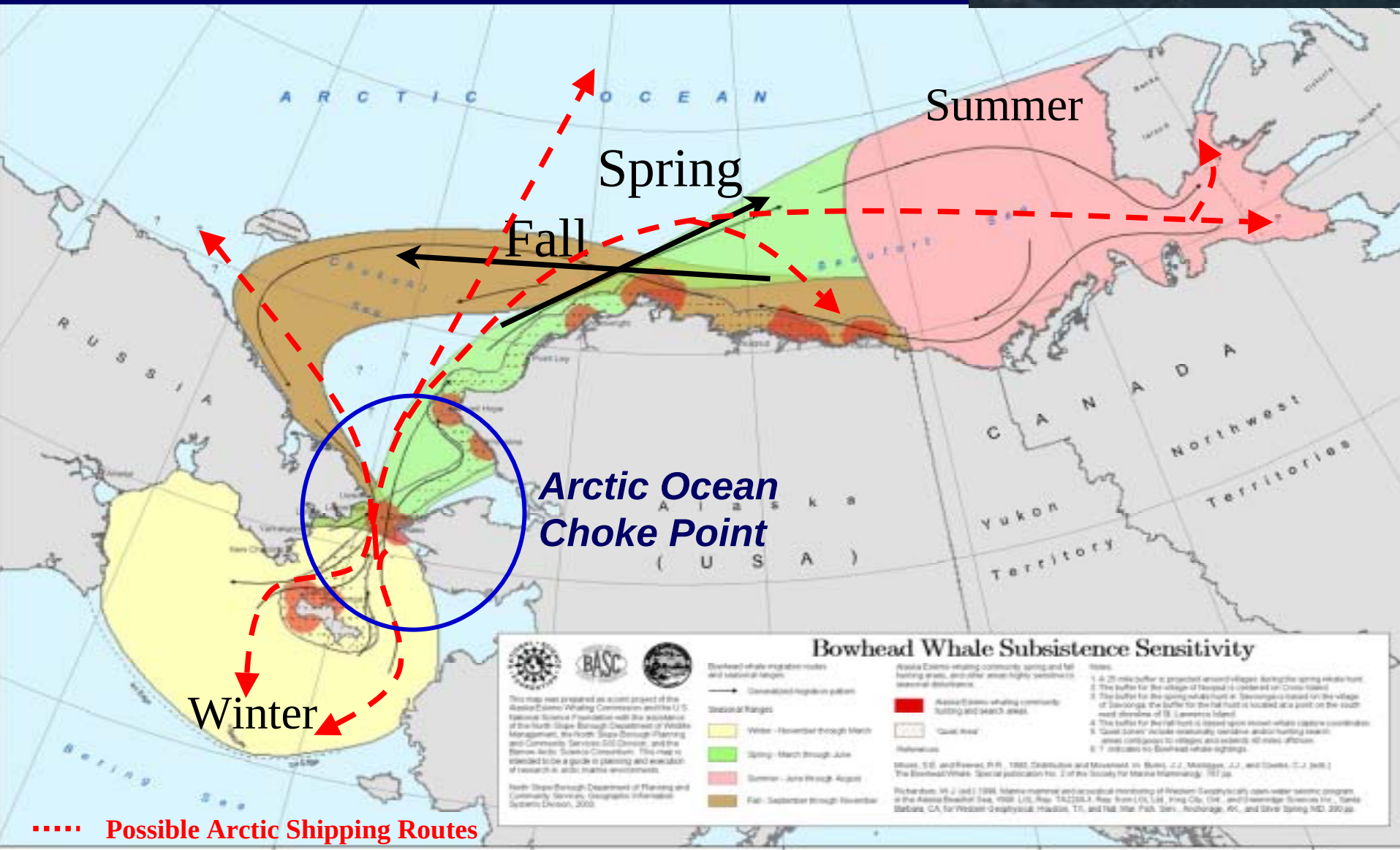


September Arctic Sea Ice Extent ~ Stroeve et al. Fig 1

Arctic Sea Ice Decline: Faster Than Forecast (GRL,1 May 07)

‘Wild Card’ Issue 1 ~ Multiple Ocean Use Management & Enforcement

Bowhead Whale Migrations & Arctic Marine Operations



‘Wild Card’ Issue 2 ~ Arctic Ship Emissions & Uncertain Regulation

New pathway to pollution in Arctic

ONE of the bonuses of global warming is the potential for new shipping routes to open up through the Arctic as ice retreats, shortening journeys by many thousands of miles. There is a downside, however. New northern passages could significantly boost levels of low-lying ozone as ship exhausts pump pollutants into the pristine environment.

Climate models indicate that the northern passages – the north-east coast of Siberia, northern Alaska and around the Canadian archipelago – may be open to shipping during the summer months from around 2050 onwards. Claire Granier, from the University of Pierre and Marie Curie in Paris, France, and her colleagues calculated the likely ozone emissions associated with such a scenario, assuming that the routes would be accessible for six months of the year.

Emissions of nitrogen oxides and carbon monoxide from ships could triple ozone levels, making them comparable to those in industrialised regions today (*Geophysical Research Letters*, DOI: 10.1029/2006GL026180).

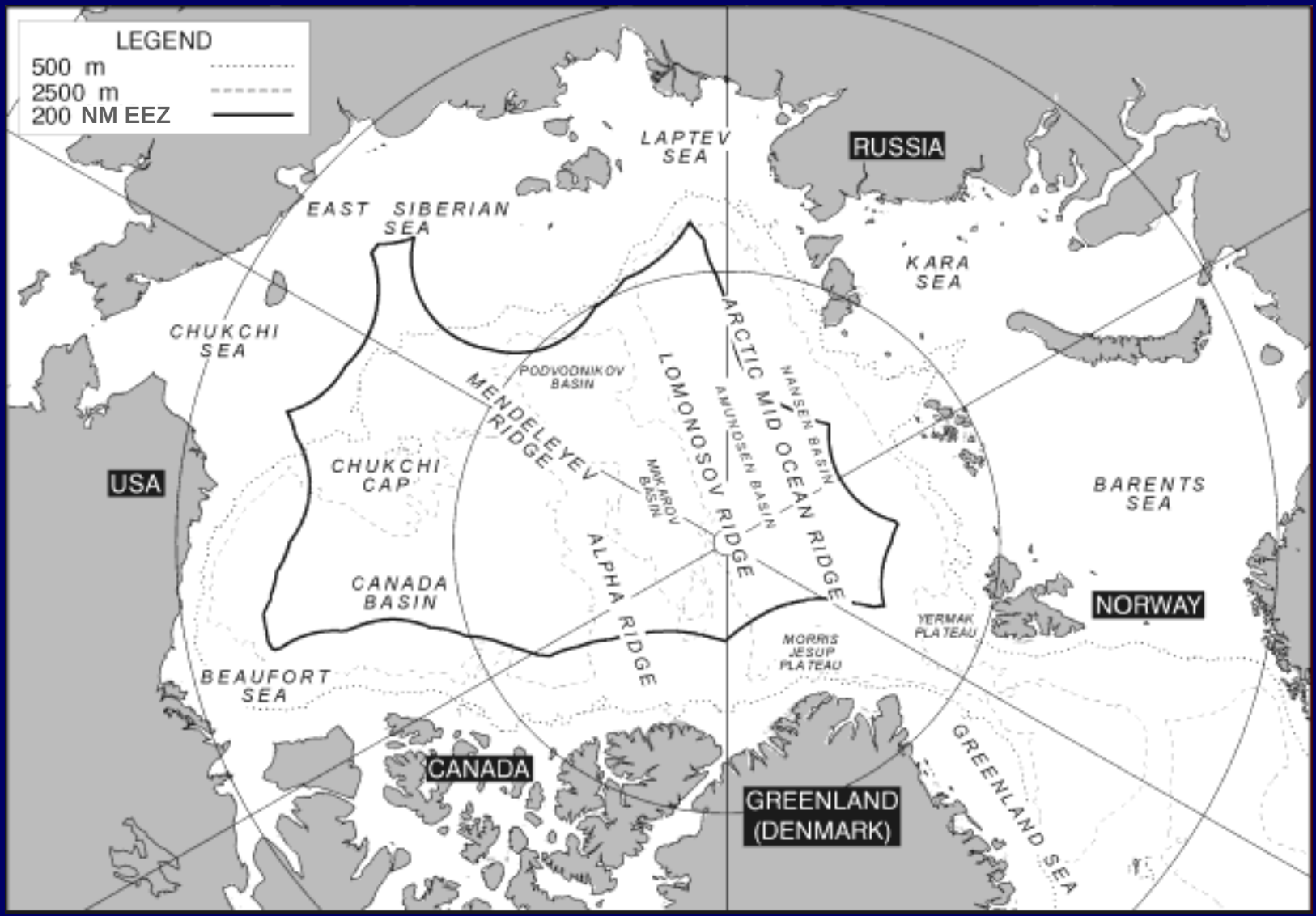
"The Arctic is a very sensitive region and these very high ozone levels are likely to have a serious impact on plant life," says Ulrike Niemeier, a co-author from the Max Plank Institute for Meteorology in Hamburg, Germany.

New northern passages could significantly boost levels of low-lying ozone as ship exhausts pump pollutants into the pristine environment.

Emissions of nitrogen oxides and carbon monoxide from ships could triple ozone levels, making them comparable to those in industrialized regions today.

New Scientist
22 July 2006

Today's Maritime Arctic
(200 NM Exclusive Economic Zone)

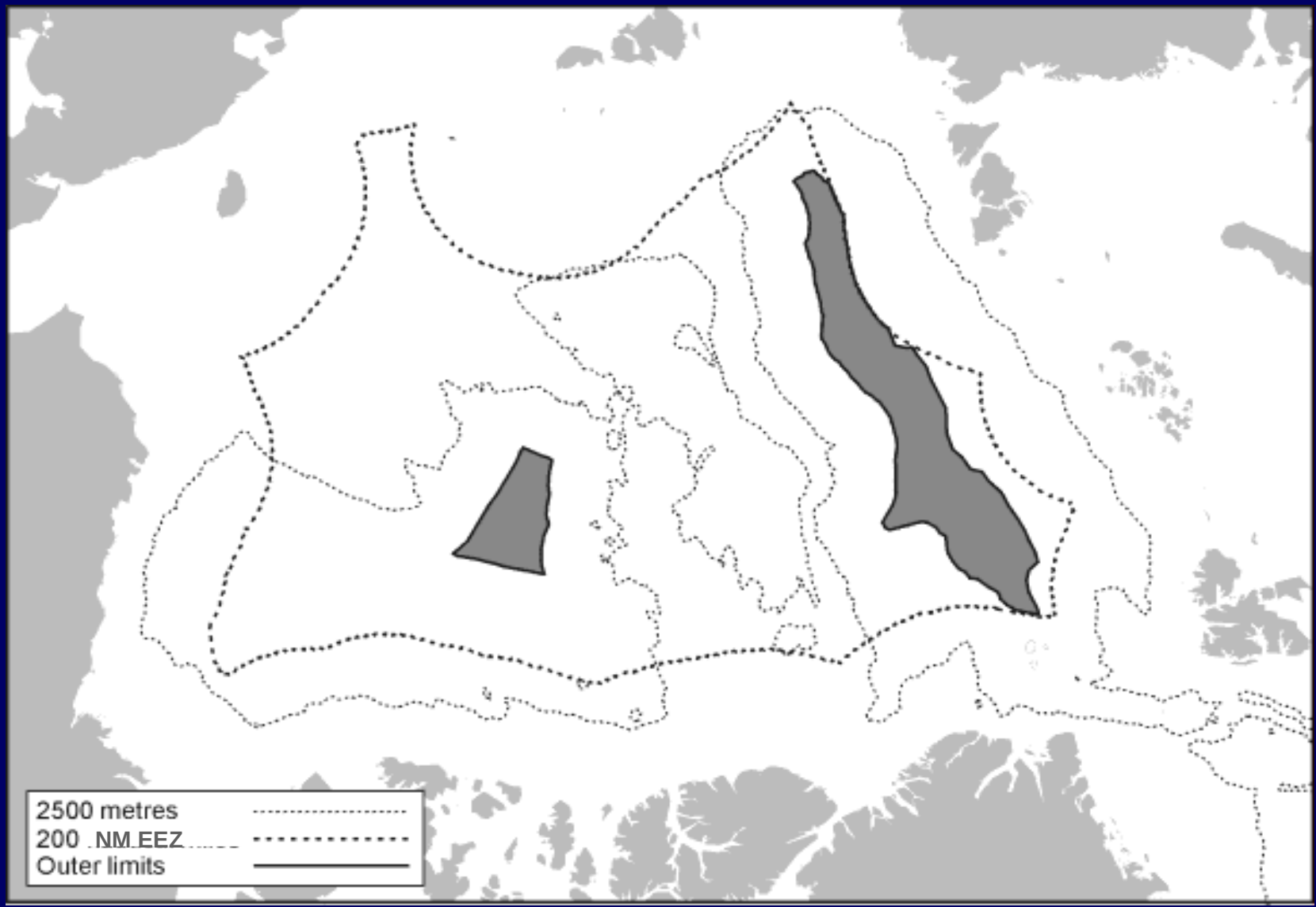


'Wild Card' Issue 3A

(Macnab 2000)

Hypothetical - Future Maritime Arctic

(After UNCLOS Article 76)



(Macnab 2000)

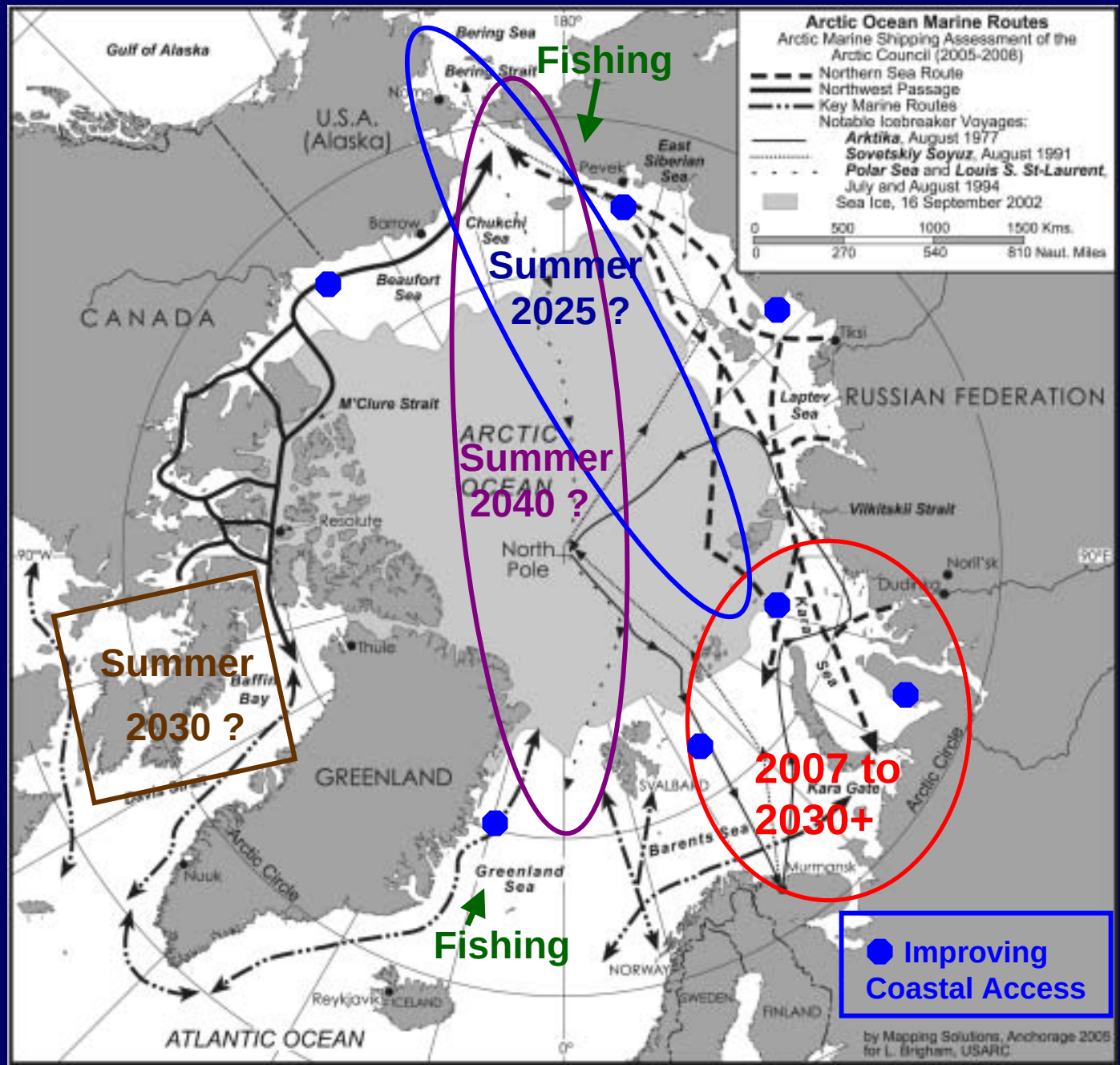
'Wild Card' Issue 3B

‘Wild Card’ Issue 4 ~ Technology

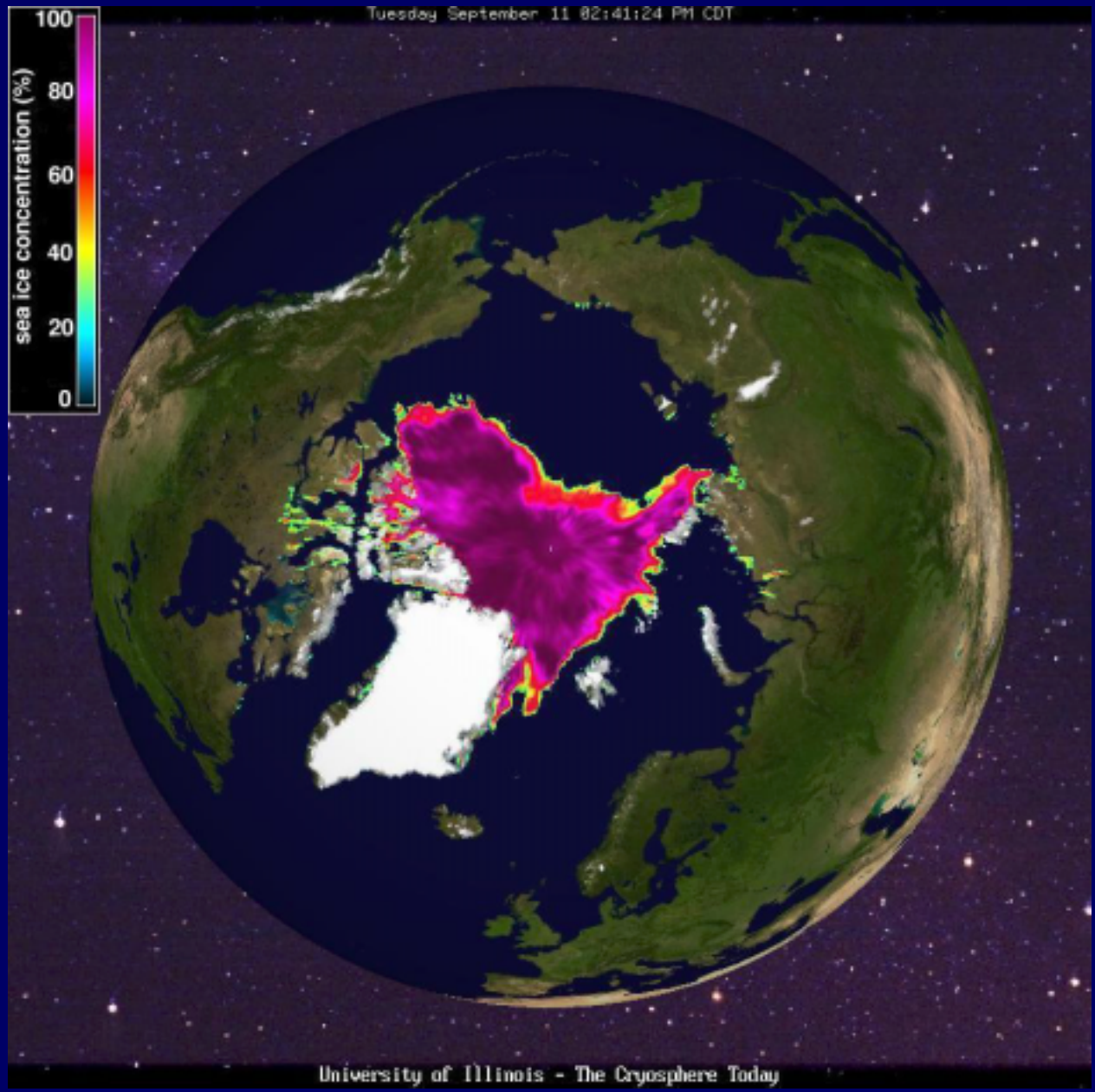
Icebreaking (Double Acting) Container Ship
***Norilskiy Nickel* in the Kara Sea**
March 2006

Aker Arctic

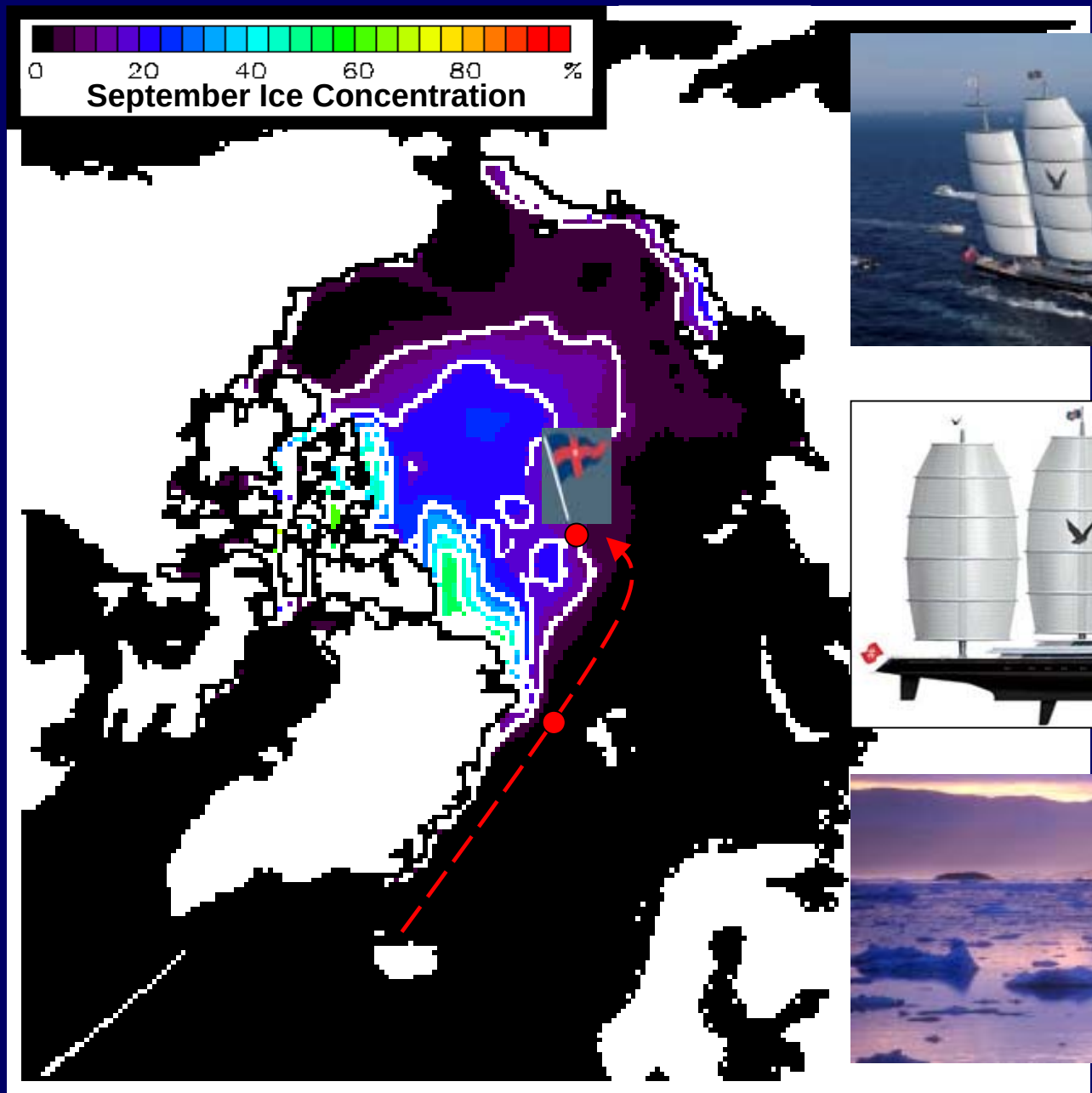
The Maritime Arctic of the Future?



Opportunities, Challenges & Risks



Sailing Cruise to the North Pole in 2035-2040 ?



AMSA Final Report Structure: Assessment Topics

- Introduction & Geography
- History & Governance
- Current Levels (2004) of Arctic Marine Use
- Indigenous Arctic Marine Use (Town Hall Meetings)
- Scenarios & Futures (2020/2050)
- Environmental Impacts
- Social & Economic Impacts
- Arctic Marine Infrastructure
- Assessment Findings & Research Agenda

Potential AMSA Findings

Primary Driver ~ Regional & Global Natural Resource Development

Lack of Integrated Governance-Regulatory Framework

Continued Sea Ice Retreat ~ Increased Access

Winter Arctic Sea Ice Cover Remains

New Ship Technologies ~ Allow Greater Access & Independent Operations (No Convoys)

Global Maritime Industry ~ Key Stakeholders

Minimal Arctic Infrastructure to Support Expanded Marine Activity

Sectors: Oil & Gas, Hard Minerals, Tourism & Fishing ~ Future: Timber & Water

Greatly Enhanced Monitoring Required

Intense Development ~ NW Russia & Norwegian-Barents-Kara Seas

Balance ~ Freedom of Navigation with Coastal State Marine Safety & Environmental Protection Interests

Lack of Experienced Mariners